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The DataShoP: A Database of Weak-Shock Constitutive Data

D. L. Tonks

MASTER

Los Alamos

Los Alamos National Laboratory
Los Alamos,New Mexico 87545

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by

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ABSTRACT

Experimental velocity profiles for weak shock waves of a variety of metals are analyzed to determine the plastic strain, plastic strain rate, and deviatoric stress through the shock front. (A weak shock wave is one that is not yet overdriven, i.e. it has an elastic precursor.) A steady-wave weak shock analysis is used for most of the data. In some cases a numerical characteristics-code calculation is used to correct for reflections created when the steady wave passes through a sample-window interface or reflects from a free surface. (The effects of a sample-window interface are minor for windows closely matched in impedance to the sample.) The data are collected here in the form of the DataShoP database: Data (from) Sho(ckwave) P(rofiles). The data are presented in the form of both figures and tables. The tables are available on request on a floppy disk. The collection of data here is a repository of basic material high-strain-rate information for the modeler or theorist. Wave propagation calculations and other such analysis have already been performed leaving the user free to concentrate on questions of basic material behavior.

I. Introduction

Particle velocity profile measurements are now available for a number of materials.[1] These measurements use the laser interferometer to determine the particle velocities of weak shock waves as these waves reflect from a free surface or enter a window transparent to the laser beam.

These measurements are important for determining the elastic-plastic behavior of materials at high strain rates. Strain rates up to $10^7/s$ are measurable with this technique, while more conventional mechanical testing machines, such as the Hopkinson bar, achieve strain rates only up to about $10^4/s$.

A superior method for analyzing weak shock waves is the steady-wave analysis of Wallace.[2,3] This method utilizes a complete thermoelastic description of solids including third-order elastic constants and entropy contributions to stresses. The effects of these quantites are often large.[3]

For the plastic-rise portion of the shock, the Wallace method assumes a steady wave, i.e. one which moves without changing in shape. Steady shock waves interacting with a transparent window are no longer quite steady, however, but contain reflections due to sample-window impedance mismatch. These reflections are easily corrected for, however, if the impedance match is a good one.[4]

The purpose of this report is to analyze available profile data and present the extracted materials-behavior in the form of the DataShoP database: Data (from) Sho(ckwave) P(rofiles). Wallace's method for steady waves is used together with occasional wave code calculations to correct for window and free surface reflections. Most of the data are from Swegle and Grady,[1] Wise and Mikkola,[5] and Chhabildas and Hills.[6] Except for the uranium and stainless steel data, these Sandia data as reported here have been corrected for window reflections using their methods. For 21-6-9 stainless steel, window reflections have been corrected for by Tonks[4] in a way including strain-rate effects. The uranium data and that of the 30-kbar series for copper by Warnes have been corrected by Tonks for free surface reflections.

The results will be given in the form of the initial *in situ* steady-wave velocity profile together with the normal stress, deviatoric stress, and plastic strain through the shock front. These quantities are given for each material studied in the form of figures and tables. The tables are available on a floppy disk by request from the author.

The task of understanding the underlying high-strain-rate material behavior has been greatly simplified for materials researchers by the work here. All wave analysis and running of codes to extract material information from raw data has been taken care of freeing the materials researcher to concentrate on the basic material behavior.

A description of Wallace's steady wave analysis and of the wave-code calculations used for analysis of the data is given in Section II. The error analysis is discussed in Section III.

The results for each material in graphical form, together with error analysis tables, are given and discussed in Section IV. Power law fits to the data are given in Section V. Appendix A contains a FORTRAN subroutine that can be used to read the DataShoP digital files into a FORTRAN program. Appendix B contains listings of the files themselves.

II. Method of Data Analysis

Most of the best quality shock-wave data available are in the form of VISAR profiles of particle velocity versus time at a sample-window interface or at a free surface. These are the sort of data studied here. The task is to extract from this data the total and deviatoric stresses and strains. This information, together with its timing, presents a picture of the plastic flow through the shock front.

A weak shock analysis due to Wallace was used to analyze most of the data. For some of the data, additional wave code calculations were done to account for reflections at windows or free surfaces. (The rest of the data were corrected at Sandia for window reflections.) This section contains a brief survey of Wallace's weak shock analysis and the wave code calculations used in conjuction with it. It also describes the author's method of estimating the third-order elastic constants when only pressure derivatives of the bulk and shear moduli are known.

A. Wallace's Weak-Shock Analysis

The weak shock analysis of Wallace[2,3] is based on a thermoelastic description for solids together with an integration of the equations of motion. It is used to extract from experimental particle velocity data the plastic strain and deviatoric stress through the shock front. This information, together with the time record, can then be used to study the strain-rate plasticity. This thermoelastic description, given in Refs. 2 and 3, applies to isotropic solids. i.e. polycrystalline materials.

The thermoelastic description involves an expansion of the total normal stress, σ, and of the deviatoric stress, τ, to include terms up to second order in the plastic strain, ψ, and the total normal compression, ϵ.

The normal compression, ϵ, is $1 - \rho_a/\rho$, where ρ_a and ρ are the initial and current densities, respectively. The plastic strain, ψ, can be defined in terms of ϵ and ϵ^e_{xx}, the infinitesimal elastic strain component in the shock direction, x:

$$\epsilon^e_{xx} = \ln(1-\epsilon) + \psi.$$

One can further define ψ in terms of the yy- and zz-components of the infinitesimal elastic strain tensor as follows:

$$\epsilon^e_{yy} = \epsilon^e_{zz} = -\psi/2.$$

The plastic strain is, thus, "equal and opposite" to the two deviatoric elastic strains. The three together maintain the lateral dimensions constant. This and the other above relations are imposed by the uniaxial-strain condition. The strains are to be regarded as small and referred to the initial configuration. The normal stress, σ, is defined to be positive in compression. It equals $-\tau_{xx}$, the xx-component of the Kirchoff stress tensor. The deviatoric stress τ, can be defined in terms of the yy- and zz- components of the Kirchoff stress tensor as follows:

$$(\sigma - 2\tau) = -\tau_{yy} = -\tau_{zz}.$$

The second-order equations mentioned above for σ and τ are the following:

$$\begin{aligned} \sigma &= (\lambda + 2\mu)\epsilon - 2\mu\psi - (1.5\lambda + 3\mu + \zeta + 2\xi)\epsilon^2 \\ &\quad + (4\lambda + 10\mu + 4\xi)\epsilon\psi - (1.5\lambda + 6\mu + 1.5\xi + .25\nu)\psi^2 \\ &\quad + 2\gamma \int_0^{\epsilon,\psi} \tau(\epsilon', \psi')d\psi' \qquad (1) \\ \tau &= \mu(\epsilon - 1.5\psi) - (\lambda + 1.5\mu + \xi)\epsilon^2 \\ &\quad + (1.5\lambda + 4.5\mu + 1.5\xi + .25\nu)\epsilon\psi - (9\mu/4 + 3\nu/8)\psi^2. \qquad (2) \end{aligned}$$

In the above equations, λ and μ are the adiabatic *Lamé* elastic constant and the adiabatic shear modulus, and ζ, ξ, and ν are related to Murnaghan's adiabatic third order elastic constants. For example, Murnaghan's l, m, and n are equal to Wallace's ζ, ξ, and ν, respectively. C_{111}, C_{112}, and C_{123} are equal to $2\zeta + 4\xi, 2\zeta$, and $2\zeta - 2\xi + \nu$, respectively. Brugger's ν_1, ν_2, and ν_3 are equal to $(2\zeta - 2\xi + \nu)$, $(\xi - .5\nu)$, and $(.25\nu)$, respectively. See Wallace[3] and references therein for further information. Included in the expression for σ is a term involving the entropy of plastic work, $2\gamma \int \tau(\epsilon', \psi')d\psi'$, which is of second order in the strains. The integration is over the path taken by the shock. γ is the Grüneisen constant.

In applying the above equations, one encounters a lack of experimental data for polycrystalline third-order elastic constants. Even where such data are available, they should be tested by using them to predict the pressure derivatives of the bulk and shear moduli for comparison with values *directly measured* by pressure. The pressure derivative measurements are not subject to the error due to microplasticity which often plagues third-order constant measurements which rely heavily on uniaxial stress. See Clifton[7] for a method of measuring third-order constants that avoids these problems.

For the present work, reliable TOE (third order elastic constants) were available only for 6061T6 Al in the work by Wallace[3] and Clifton.[7] Other sets available for Fe and Cu[8] failed the comparison with measured pressure derivatives. However, measured pressure derivatives of the bulk and shear moduli were available for all the materials studied here. The author was able to proceed by using the following method. Express two of the TOE, viz. ξ and ν, in terms of the two pressure derivatives and the third TOE, ζ. Then calculate all results with reasonable values of ζ to demonstrate that the results are insensitive to this variation.

The sensitivity for the stainless steel and copper, for example, is surprisingly small. The final results depend very little on the ζ variation. This insensitivity has the following theoretical basis.[9] When Eqs. (1) and (2) above for τ and σ are re-expressed in terms of the bulk- and shear-moduli pressure derivatives and ζ, the resulting term in μ', the adiabatic pressure derivative of μ, has the factor $(\epsilon - 1.5\psi)$. The corresponding term in ζ has the factor $(\epsilon - 1.5\psi)^2$. From about mid-shock on, this factor of ζ is always small since ϵ is then close to 1.5ψ in order to reduce the deviatoric stress. For the limiting case where the deviatoric stress at the shock end is zero, this term is exactly zero at the shock end. Hence, from about mid-shock on, the term in ζ is about an order of magnitude less than τ itself, which is of order $\mu(\epsilon - 1.5\psi)$. At the beginning of the shock, the strains are small and the TOE terms are not important. Hence, the ζ-term is not important there either, and the insensitivity to ζ is explained. These considerations are qualitative, however, and could change with unusual parameter values. Hence, the procedure of varying ζ should be tested out on a case by case basis, as was done here.

The equations giving ν and ξ in terms of the pressure derivatives and ζ are as follows:[10]

$$\begin{aligned} \nu &= 1.5(-3B'B - 6\zeta) \\ \xi &= (-3\mu' B - 3B - \mu + .5\nu)/3, \end{aligned} \tag{3}$$

where B is the adiabatic bulk modulus and the primed quantities are the corresponding adiabatic pressure derivatives. The experimental pressure derivatives are usually at constant temperature, so to convert them to adiabatic derivatives, the following relationship was used: $(\partial B/\partial P)_S = (\partial B/\partial P)_T + (\partial B/\partial T)_P(T\beta)/(\rho_a C_P)$. where S is the entropy, T is the temperature. β is the volume coefficient of thermal expansion at constant P. The analogous relationship was used for the shear modulus. $(B')_T$ and $(\mu')_T$ will be used here to denote $(\partial B/\partial P)_T$ and $(\partial \mu/\partial P)_T$, respectively.

The other part of the Wallace weak shock analysis consists of the integration of the equations of motion. The velocity profiles dealt with by Wallace[3] consisted of a steady plastic portion with a precursor section that stretched out with travel in front of the steady plastic portion. As Fig. 1 illustrates, in a record taken at constant position, this precursor portion behaved experimentally like an abrupt elastic rise to a point on the wave, called point b, with roughly constant particle velocity, v_b. The particle velocity then grew linearly in time until another point, point c, was reached at the base of the steady plastic portion. Point c had roughly constant particle velocity, v_c. The time required for the particle velocity to rise from v_b to v_c became gradually longer as the precursor stretched out with travel since point b traveled at a higher velocity than the velocity of point c, which moved at the the shock velocity D. Point b traveled at velocity c_p, which is a finite-strain Lagrangian sound velocity.

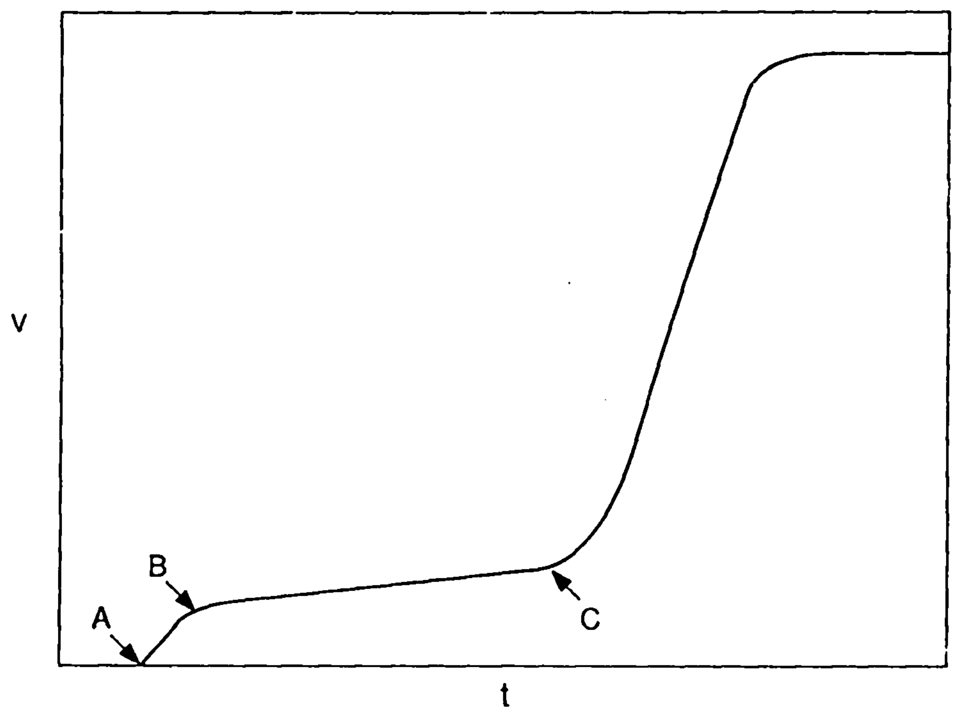

Fig. 1. Points of the velocity profile important in the Wallace steady wave analysis.

This precursor behavior can be utilized to integrate the equations of motion for the precursor portion[3] to arrive at the following formulas for ϵ and σ in terms of v, the particle velocity:

$$\epsilon = \epsilon_b + \frac{v - v_b}{c_p}\left(1 + \frac{\delta(v - v_b)}{2(v_c - v_b)}\right). \tag{4}$$

$$\sigma = \sigma_b + \rho_a c_p \left(\frac{v_c - v_b}{\delta}\right) \ln\left(1 + \frac{\delta(v - v_b)}{(v_c - v_b)}\right). \tag{5}$$

The subscripts "c" and "b" refer to the previously discussed points c and b of the shock. The subscript "a" refers to the initial condition, or the point on the shock just before the elastic rise. δ is the quantity $(c_p - D)/D$. Here, ϵ_b is to be obtained from v_b/c_p from experimental values for v_b. σ_b is to be obtained from $\rho_a c_p v_b$.

The equations of motion can be integrated along the plastic steady wave portion using the steady wave assumption. The results for ϵ and σ are the following:

$$\epsilon = \epsilon_c + D^{-1}(v - v_c), \tag{6}$$

$$\sigma = \sigma_c + \rho_a D(v - v_c). \tag{7}$$

The above equations are used in analyzing an experimental profile in the following way. First σ and ϵ are calculated from particle velocity data and the measured shock velocity using Eqs. (4), (5), (6), and (7). The calculated σ and ϵ are then used with Eqs. (1) and (2) to find ψ and then τ.

In the calculation for ψ using Eq. (1), the integral in $\tau d\psi'$ is handled iteratively. First ψ is calculated leaving the intergral out. τ is then calculated from Eq. (2) from these lowest order ψ-values. Then the lowest order ψ and τ are used in the integral to calculate a better approximation to ψ. The procedure is repeated until convergence. In the calculations here, one or two iterations were adequate.

B. Window Reflections and Free-Surface Reflections

The data for many of the materials was taken through a transparent "window" placed in back of the sample to reduce as much as possible the changes in the wave that would take place in reflecting from a free surface. For most of the materials investigated, the windows were well matched in impedance to the materials so that the actual profile measured was close to the *in situ* wave in the material.

Except for the uranium data, the data obtained from Sandia Laboratories was taken through windows. With the exception of the stainless steel data, the window data were already corrected for the minor window reflections before being released to the author,[11] or published[6] in the literature.[3] The window-corrections method was probably that of Grady and Young.[12] This method does not take into account plastic strain-rate effects but was probably adequate for the small corrections involved. The Sandia data falling into this category include that of 6061T6 Al, Be, Bi, Fe, V, and the 54-kbar shot for Cu.

In the work on window reflections,[4] the distortions in the data due to window reflections were studied for Cu and 21-6-9 stainless steel (SS) and found to be small. A modification of the characteristics wave code (CHARADE)[13] was used with iterations to find an *in situ* steady wave together with a consistent plastic-strain-rate law which produced quite accurately the experimental profile. The final calculation in the iteration involved an initial condition in particle velocity and time (the *in situ* wave) which was analyzed using Wallace's weak shock analysis to get a strain-rate constitutive law which was then used to propagate the initial condition through the sample-window interface. It was possible to achieve quite good agreement between the calculated and experimental particle velocities at this interface. At the beginning of this final calculation, the accuracy of the constitutive law was checked by using it to recalculate the initial condition from scratch for comparison with the original initial condition. Only quite good comparisons were tolerated.

The constitutive law used to fit the results of the Wallace analysis giving the plastic strain rate, $\dot{\psi}$ as a function of ψ and τ is the following:

$$\dot{\psi} = 10^d(\tau - \tau_y - h\psi)^g(\psi + \psi_a)^c, \tag{8}$$

where d, h, g, and c are constants to be fitted. τ_y is the constant yield strength which is calculated from a choice for v_b using the equations in Section II. The terms τ_y and $h\psi$ provide zero strain rate at the beginning and ending of the shock, respectively. ψ_a is a small initial plastic strain used to give a very small nonzero $\dot{\psi}$ to properly begin the wave-code calculations.

The 21-6-9 SS results presented here were obtained in the above described fashion.

The 30-kbar Cu data of Warnes and the U-data of Grady involved measurements of particle velocity at a free surface, in which the wave reflection effects are expected to be more serious than those at a window. The iterative wave-code procedure was also used to analyze these data with the window being a "vacuum". The free surface reflection, however, involves more complicated plasticity behavior than that at a window since full elastic unloading and reloading take place there. The strain-rate plasticity relation needed in the code must also describe unloading and reverse plastic flow. In the case of a window, only "forward" strain-rates are involved and the code constitutive relation is never called upon, in running the initial condition through the window, to depart very far from the steady-wave constitutive data obtained from the initial condition. The whole problem is essentially a perturbation around the steady wave condition and only small extrapolations therefrom are necessary.

In contrast, in a free-surface reflection, a wider range of plasticity is involved and the observed profile at the free surface is further removed from the *in situ* steady wave. In a free-surface-reflection calculation, this wide range of plasticity behavior must be modeled and this modeling is more arbitrary.

In the case of the 30-kbar Cu data of Warnes, however, it was found that the calculated free surface profile was not very sensitive to the model of reverse plasticity used. (This was not the case for 50-kbar data, however.) The strain-rate model used in fact contained a yield surface, so that a portion of the reverse loading path was elastic, and used the same algebraic form for both positive and negative strain rates with a simple change of sign for the effective stress and strain rate. The elastic excursion produced only quite minor features in the calculated free surface profile which hardly degraded the comparison of data to calculation at the free surface. The features were not present in the data, but their presence in the calculation was so weak as not to be a problem. In summary, for the 30-kbar calculations, an *in situ* initial condition was found by iteration which was consistent with its forward-strain-rate law (obtained from it by the Wallace analysis as described above), and that produced a good match with the free surface data. The forward-strain-rate-law was used for reverse plastic flow as described above. The results of this procedure for the 30-kbar Cu data are reliable due to the lack of sensitivity to the law for reverse plastic flow.

In the case of the uranium data analysis, the calculated free surface velocities *do* contain features sensitive to the model for reverse plastic flow. A reverse-plastic-flow model with a yield surface fails to match the data. The elastic excursions produce pronounced features not present in the data. A reverse-plastic flow model in which no yield surface is present but in which reverse plastic flow begins immediately after forward flow ceases produces a much better fit to the data.

For the present uranium data analysis, this reverse-plastic flow model was obtained from the power law for forward plastic flow by using the same power law coefficients d, g, and c with a new "effective" stress $h\psi - (\tau)$ and a change in sign of strain rate. Thus, for reverse plastic flow, the strain-rate law used was:

$$\dot{\psi} = -10^d(h\psi - \tau)^g(\psi + \psi_c)^c. \qquad (9)$$

For the present uranium data analysis, the forward strain rate law was obtained by the approximation of dividing the particle velocity data by two and analyzing the results with Wallace's method. The result of running the data divided by two as an initial condition with this constitutive law was in fair agreement with the free surface data. Iteration with the wave code produced better agreement for the cases tried but was deemed not worth the effort due to the uncertainty in the reverse-plastic flow model. Since it was obtained from the law for forward plasticity, the law for reverse plastic flow must possess generally plausible behavior but is otherwise arbitrary. The results for all the uranium profiles were obtained in the manner described above.

The reverse-plastic-flow behavior is a topic of current research and progress in understanding it will be used to update the uranium results.

See Ref. 4 for more description of the wave-code iteration procedure for the case of a window.

III. Error Analysis

An extensive error analysis of the Wallace method for analyzing steady waves was done for a typical velocity profile of each material of this study. This analysis involved varying the elastic constants, the experimental shock velocity, and the choice of the point where the precursor ends and the plastic wave begins over ranges based on available data. The choice of the point where the precursor elastic rise ends was also varied for profiles having such a rise.

Errors in measuring particle velocity and shot to shot variations were not investigated in this way, but an idea of their importance (which appears to be minimal) can be obtained by comparing the results for the three 30-kbar Cu shots which nominally differ only in sample thickness.

The assumption of a steadiness in the plastic wave portion which is crucial to the analysis used here is difficult to check without a series of experiments in which only the sample thickness is varied. Such data are included here for 6061T6 Al and the 30-kbar Cu series by Warnes. For this data, the invariance of the plastic wave to shock thickness supports the steadiness assumption. The 89-kbar 6061T6 Al shot is not accompanied by others of different sample thickness, but since its weaker companion shots are steady, it probably is steady also. The stronger shock waves tend to shock up faster. The 54-kbar Cu shot from Swegle and Grady is probably steady at a sample thickness of 6.36 mm since the 30-kbar Cu shot H800 of Warnes is steady at a sample thickness of 10 mm. The steadiness of shot Be14 for beryllium is substantiated by another shot[14] (not included in the data base) of differing sample thickness. Shot Be18 included here, of weaker shock strength, is not so substantiated however, and could be somewhat unsteady. The steadiness of the two Bi shots included here are substantiated by others[15] not included here. The steadiness of shot Fe16 for iron included here is substantiated by another[16] (not given here). Shot Fe15 is not, but is of similar sample thickness to shot Fe16 and only slightly weaker, and so, is probably steady.

It is worth noting that possession of velocity profiles of varying sample thickness for the same shock strength also allows a better choice of points c and b (see Fig. 1) necessary for the Wallace shock analysis. Point c is the point where the nonsteady "precursor" ends and the plastic steady wave begins. Such a point does not strictly exist; assuming its existence is an approximation.

The shots for materials 21-6-9 SS, V, and U were not done with varying sample thicknesses to check for steadiness. However, since weak shock waves of sufficient strength seem to achieve steadiness in just a few mm of sample thickness, these shots, all of which involve substantially greater sample thicknesses than this, are probably steady. The weakest shot V1 for vanadium and the weakest shots AV3 and AV4 for uranium were left out because they did not "look" steady. Their peak particle velocies are not much greater than their peak precursor particle velocities.

Of all the shots included here, only the 89-kbar 6061T6 Al and shot Be14 for beryllium suffered from lack of time resolution. To fill out the 89-kbar profiles, points were interpolated by Wallace into the 89-kbar shot record to obtain the velocity profile given here.[3]

Some uncertainty arises in the data analysis due to assumptions necessary in evaluating the precursor rise, the first rise in the velocity profiles. For Cu, Bi, and Be no such rise is seen and so no uncertainty results. The precursor rises for 6061T6 Al are quite sharp and unmistakably elastic, so no uncertainty arises here either. The precursor rises for Fe, U, V, and SS are sloped, however, and their nature is less certain. For Fe, U, and V, however, data for several shock strengths at the same sample thickness are available which show almost the same precursor structure for all strengths. This is taken here as evidence that these precursor rises are elastic in nature, which is how they were treated in the data analysis. No such data are available for 21-6-9 SS, whose precursor rise was also assumed to be elastic, but this material is known to have a high yield stress which would give rise to a strong elastic precursor rise.

Point b, the end of the elastic rise, was taken to be the very peak of the precursor rise. Some idea of the error in the results due to uncertainty in the precise location of the end of the precursor rise is given in the error analysis. The error appears to be minor.

The rest of the error analysis, that involving the Wallace steady wave analysis, is contained for each material, in its particular subsection.

The deviatoric stress, τ, is most sensitive to the uncertainties in the analysis. In particular, the deviatoric stress at the end of the shock rise, τ_e, is particularly sensitive, because at this point in the shock, the elastic and plastic strains' contributions to τ are almost cancelling each other giving rise to a delicate balance. The calculated peak deviatoric stress, τ_p, is much less sensitive and more reliable.

By contrast, the uncertainty in the plastic strain ψ and plastic strain rate $\dot{\psi}$ is much smaller. For most parameter variations in the error analysis, i.e. variations of D, elastic constants, and points b and c of the Wallace analysis, the plot of $\dot{\psi}$ versus ψ changed very little, for example. Only for parameter variations for which τ_e varied by, say, 40% or more did this plot change in noticeable fashion, the final plastic strain changing by 10%, for example.

Because of this lack of sensitivity, the effects of the parameter variations are only given for τ and not for ψ. The percentage changes in τ_e at the end of the shock and in τ_p, the peak deviatoric stress, are given in terms of percentage changes of the parameters considered.

The most sensitive parameters are, in order of sensitivity, the shock speed, D: the bulk and shear moduli, B and μ, and the pressure derivative of the bulk modulus, $(B')_T$. For the best results, the shock speed D should be known experimentally to better than 1/2% accuracy and the bulk modulus to 1% or so. For purposes of the weak shock analysis, it is much preferable to measure shock speeds at the same time as particle velocity data are measured and to measure ultrasonic sound speeds on the same material shot to obtain B and μ.

Except for Bi, knowledge of only pressure derivatives of B and μ as opposed to a full set of third order elastic constants seemed sufficient for the materials studied here due to the insensitivity of the results to variation (as described earlier) of the ζ-TOE with $(B')_T$ and $(\mu')_T$ known. ζ was varied through a physically reasonable range within which the other two TOE, ξ and ν, remained less in magnitude than some reasonable limit, usually about 10 Mbar. The biggest magnitude for metals for ζ, ξ, or ν, reliable or not, known to the author is about 10 Mbar. The materials upon which this is based include steels, iron, copper and copper alloys, aluminum and aluminum alloys, magnesium, molybdenum, tungsten, vanadium, uranium, beryllium, and bismuth.

Another possible source for error is the possible breakdown, i.e. inadequacy, of the expansion of the thermoelastic equations to second order in the strains used in the Wallace analysis. To check on this potentiality, versions of τ_p and τ_e taken to only first order in the strains were calculated and compared to the full, second-order versions. The ratio $\tau(1st)/\tau$, where the (1st)

Quantity	Change, Exp. Range $(qnty. \div std.)$	$\tau_p/\tau_p(std.)$	$\tau_e/\tau_e(std.)$
D($cm/\mu s$)	1.→ 1. ± .007	1. →0.93	1.→ 1. ± 0.17

Table 1: Parameter Variations for 6061T6 Al

Material	Density (g/cm^3) ρ_a	*Lamé* Constant (Mbar) λ	Shear Modulus (Mbar) μ	(Mbar) ζ	(Mbar) ξ	(Mbar) ν
6061T6 Al	2.703[3]	0.544[3]	0.276[3]	-1.40[3]	-2.82[3]	-4.69[3]

Table 2: Material Properties for 6061T6 Al

refers to a first-order version, are reported for the peak and end deviatoric stresses in the individual sections on materials. In only a few cases did the second order expansion seem inadequate. Unfortunately, measured fourth-order elastic constants for metals necessary for the next-higher-order version of the expansion are almost nonexistent.

IV. Results

This section has a subsection for each material containing the detailed error analysis and results of the data reduction. Figures are to be found at the end of the main text just after the references. Tables of the data used to make the figures are to be found in Appendix B. Most of the parameter variations will be given in the form of tables. Tables will also give material properties and shot information. Special information and salient features will be noted in the text.

A. Constitutive Data and Error Analysis for 6061T6 Aluminum

Figures 2 - 8 for 6061T6 Al are to be found on pages 38 - 44. They show particle velocity, total and plastic strains, normal stress, and deviatoric stress plotted versus time; deviatoric stress plotted versus plastic strain; and plastic strain rate plotted versus plastic strain and deviatoric stress. Tables 1 - 4 give parameter variations, material properties, and shot information.

The data points in the data base for 6061T6 Al correspond to actual data points except for the four points for the 89-kbar profile between about 0.173 and 0.425 $mm/\mu s$ which were interpolated as a straight line in particle

Material	Grüneisen constant γ	Heat capacity (erg/g K) C_v
6061T6 Al	2.16[3]	0.88x10^7 [3]

Table 3: Material Properties for 6061T6 Al

Shot I.D.	Normal Stress (kbar)	Sample Thickness (mm)[3]
922	21	12.5
939	21	31.6
936	37	6.13
927	37	12.2
937	37	37.9
926	89	12.5

Table 4: Plate-Impact Shots for 6061T6 Al

velocity versus time.[3] The velocity profile numbers were taken from Wallace's notes[9] which are based on the original data notebooks of Johnson and Barker.[17] These velocities, however, were also corrected slightly for window effects.[17]

The shock velocities were measured by Johnson and Barker from absolute timing measurements, which are to be preferred to any sort of mix of calculated precursor speeds and relative shock speeds. Wallace's paper shows an average scatter in these measurements of about ±0.7% around the D-values given by his $U_s - U_p$ fit: $D = 0.526cm/us + 1.47U_p$, where U_p is the peak particle velocity of the shock wave. This fit was used for D in all the calculations.

The elastic constants, including a complete set of TOE, were measured for 6061T6 Al by Clifton.[7] The method for measuring the TOE was specially designed to rely more on pressure than longitudinal stress to avoid errors from plastic microstrain that plague the usual sort of measurements done. The pressure derivative of B, i.e. $(B')_T$, calculated from Clifton's TOE was about 5.27 for comparison with that of pure Al which is about 5.3. By contrast, a complete set of TOE measured by Asay et al.[18] by a method relying on uniaxial stress results in a calculated $(B')_T$ of about 8.9.

Only such error analysis as available from Wallace's work is repeated here, since this is Wallace's work. He estimated the error in τ_e as being roughly ±17% due to errors of ±0.7% in the experimental shock velocity. The estimated error in ψ_e was about ±3%. Since the elastic constants appear to be reliable for this case, most of the uncertainty in the data analysis is expected to arise from this uncertainty in the shock velocity and the errors resulting therefrom can be taken as representing the total error.

The value for v_c was taken to be $50 m/s$ for all shots execpt for shot 937 for which v_c was $53 m/s$.

B. Constitutive Data and Error Analysis for Beryllium

Figures 9 - 15 for beryllium are to be found on pages 45 - 51. They show particle velocity, total and plastic strains, normal stress, and deviatoric stress plotted versus time; deviatoric stress plotted versus plastic strain; and plastic strain rate plotted versus plastic strain and deviatoric stress. Tables 5 - 8 give parameter variations, material properties, and shot information.

Quantity	Std. Value	Change, Exp. Range ($qnty. \div std.$)	$\tau_p/\tau_p(std.)$	$\tau_e/\tau_e(std.)$
D($cm/\mu s$)	0.8438	1.→0.9931	1.→0.93	1.→0.55
$\lambda(kbar)$	172.5	1.→0.90	1.→1.18	1.→2.02
$\mu(kbar)$	1509.3	1.→0.982	1.→1.18	1.→2.02
$(B')_T$	4.60	1→1.02	1.→1.003	1.→0.95
$(\mu')_T$	2.3	1.→1.17	1.→1.0	1.→1.0
$v_c(m/s)$	38.39	0.8→1.17	0.88→1.11	0.71→1.26
$\zeta(Mbar)$	-5.5	-11.→16.5 abs. values	1.0→1.0	1.0→1.0

Table 5: Parameter Variations for shot Be18. λ and μ were varied jointly.

Material	Density (g/cm^3) ρ_a	Lamé Constant (Mbar) λ	Shear Modulus (Mbar) μ	$(dB/dP)_T$ $(B')_T$	$(d\mu/dP)_T$ $(\mu')_T$	dB/dT (kbar/K)
Be	1.851[19]	0.1725[19]	1.5093[19]	4.60[10]	2.3[10]	-0.20[23]

Table 6: Material Properties for Be

The beryllium material shot was about 98% pure with 35 μm grain size.[19]

The data points for beryllium in the data base correspond to actual data points from Sandia.[1] The velocity profiles given here are the same ones obtained from Sandia. They were corrected there for window reflections, and so do not represent raw data, however.

Material	$d\mu/dT$ (kbar/K)	Grüneisen constant γ	Heat capacity (cal/g K) C_p	Linear expansion K^{-1} α
Be	-0.28[23]	1.11[10]	0.438[24]	1.39x10^{-5} [25]

Table 7: Material Properties for Be

Shot I.D.	Normal Stress (kbar)	Sample Thickness (mm)[19]
Be18	63	8
Be14	172	9

Table 8: Plate-Impact Shots for Be

The data were taken through LiF windows.

The measured shock velocites for the two shots included here were based on absolute timing measurements. The $U_s - U_p$ relation: $D = 0.7982 cm/\mu s + 1.131 U_p$ fitted to the shock velocity data was used in the data base calculations. The individual-shot D-values for shots Be14 and Be18 differed from their fitted values by 0.69% and 0.86%, respectively, which can be taken as a measure of the error in the measured D-values. The former measured value was used for the D-parameter variations.

Values for the elastic constants B and μ were available from Wise et al.[19] from ultrasonic measurements done on the actual material shot, and from Silversmith and Averbach[20] and Smith and Abrogast.[21] The latter two sources reported single crystal constants which were averaged (1/2(Voigt + Reuss)) to obtain equivalent polycrystal values. The Voigt and Reuss values fell quite close to one another so that the averaging gave reliable results in this case.

The B and μ values from Wise et al. were taken as "standard" and used to generate the data tables.

Using Silversmith and Averbach's values for B and μ in the data analysis gave the unacceptable resul $\tau_t \approx \tau_p$ so these values were excluded from consideration. Their B and μ values were 0.94 and 1.00 times the standard ones, respectively.

The λ and μ variations in Table 5 are based on the B and μ values of Smith and Abrogast which were 0.90 and 0.982 times the standard ones, respectively.

Values for $(B')_T$ were available only from Voronov and Vereshchagin[22] (4.69) and from Silversmith and Averbach (4.60).[20] The latter, as reported by Guinan and Steinberg,[10] was taken as standard and the former used for parameter variation. The Voronov et al. value was for a polycrystal. The Silversmith et al. value involved averaging single crystal values, which gave reliable polycrystalline values for this case, as noted previously.

Values for $(\mu')_T$ were also available only from Voronov et al. (2.7) and Silversmith and Averbach (2.3). The latter value, as reported by Guinan and Steinberg[10] was taken as standard, with the former value being used for the error-analysis variation.

The parameter variations were done for the shot Be18.

The value of ζ was varied in the range $-11Mbar < \zeta < 16.5Mbar$ which resulted in the range $-172.5Mbar < \nu < 75.0Mbar$ for ν, the larger in magnitude of the other two TOE. Only small changes in τ, and hence in all other calculated quantities, resulted from this variation.

The values for $\tau_p(1st)/\tau_p$ and $\tau_\epsilon(1st)/\tau_\epsilon$ were 0.84 and -0.24, respectively.

The values of v_c for shots Be18 and Be14 were 38.39 and 44.88 m/s, respectively.

A comment is in order concerning the lack of an elastic rise in the precursor in the experimental velocity profiles. Beryllium is known to have a fairly high yield stress[1] which should produce a well defined elastic rise. The absence of such a rise in the data must be due to some pronounced smearing mechanism. The data analysis here is no doubt affected by not including this rise, but none can be seen in the data. Figure 13 showing deviatoric stress versus plastic strain does show an abrupt rise at very small plastic strain which is reminiscent of a yield transition, however. Hence, it seems likely that the plastic yield transition is captured in the analysis here to some approximation.

C. Constitutive Data and Error Analysis for Bismuth

Figures 16 - 22 for bismuth are to be found on pages 52 - 58. They show particle velocity, total and plastic strains, normal stress, and deviatoric stress plotted versus time; deviatoric stress plotted versus plastic strain; and plastic strain rate plotted versus plastic strain and deviatoric stress. Tables 9 - 11 give material properties and shot information.

Material	Density (g/cm^3) ρ_a	*Lamé* Constant (Mbar) λ	Shear Modulus (Mbar) μ	$(dB/dP)_T$ $(B')_T$	$(d\mu/dP)_T$ $(\mu')_T$	dB/dT (kbar/K)
Bi	9.777[15]	0.2441[27]	0.1217[27]	5.54[27]	1.92[27]	-0.062[26]

Table 9: Material Properties for Bi

Material	$d\mu/dT$ (kbar/K)	Grüneisen constant γ	Heat capacity (cal/g K) C_p	Linear expansion K^{-1} α
Bi	-0.0897[26]	1.1[1]	0.1247[30]	1.34x10^{-5} [31]

Table 10: Material Properties for Bi

Shot I.D.	Normal Stress (kbar)	Sample Thickness (mm)[15]
147	11	4.060
149	23	3.042

Table 11: Plate-Impact Shots for Bi

The material used for the bismuth shock work was 325 pressed polycrystal powder of 99.999% purity. The average grain size was 15μm and the average ρ was within 0.3% of theoretical density.[15] The experiments analyzed here were done at room temperature.

The data points in the data base for Bi correspond to actual data points. The velocity profile given here is the same one obtained from Sandia. It was corrected there for window effects, however, and so is not raw data.

The data were taken through a fuzed silica window.

The original paper by Asay[15] does not quote shock velocities. The shock velocities used for the database calculation were taken from Swegle and Grady's $U_s - U_p$ relation: $D = 0.1826 cm/\mu s + 1.473 U_p$.[1]

Polycrystalline elastic constants with pressure derivatives of B and μ are available from Fritz[26] and Voronov and Stal'gorova.[27] Calculated polycrystalline averages based on single crystal values of Eckstein et al.[28] for B and μ for two crystals are available from Anderson.[29] Asay did not measure ultrasonic sound velocities.[15]

The results for Bi varied so wildly with choice of elastic constants and D that the results given here are only a guess. τ_p could be off by as much as ±70%. This is considerably more uncertainty in this quantity than for the other materials. The reason for all of this seems to be the wider than usual experimental variation in B and μ values and the special sensitivity of the results to these quantities. This sensitivity is due to the relatively small values of B and μ compared to the TOE, which are as large as most other metals. For example, λ and μ due to Voronov are only 244.1 and 121.7 kbar, respectively; while $(B')_T$ and $(\mu')_T$ are 5.54 and 1.92, respectively.

Only the elastic constants and pressure derivatives of Voronov used with Swegle and Grady's $U_s - U_p$ relation gave all nonnegative values for τ. Fritz's elastic constants and pressure derivatives resulted in negative values for τ

(unphysical) for the latter part of the shock rise. Shock velocities about 5% larger than those from the $U_s - U_p$ relation estimated from graphs in the original paper[15] gave equally disasterous results.

Fritz's elastic constant values could be too large. His λ and μ are 10% and 15%, respectively, above those of Voronov. The averages of Anderson's λ and μ values for the two crystals are only about 6% and 2% higher, respectively, than Voronov's values, suggesting that Voronov's are closer to the truth.

Fritz's value for $(B')_T$ is 6.55, not too far from the value 5.54 given by Vorononv. Fritz's value for $(\mu')_T$ is also close to Voronov's: 2.03 (Fritz) compared to 1.92 (Voronov). The experimental pressure-derivative-values are probably not the cause of the data analysis problem.

The value of zero was used for ζ. This gave rise to ν and ξ values smaller in magnitude than 10 Mbar. Values for these two TOE grew rapidly in magnitude with variation of ζ from zero.

The values of $\tau(1st)_p/\tau_p$ for shots 147 and 149 were 0.88 and 0.76, respectively. The values of $\tau(1st)_e/\tau_e$ for shots 147 and 149 were 0.74 and 0.40, respectively. So the data analysis probiem is not due to a breakdown of the second-order thermoelastic model.

The values used for v_c were 12.7 and 12.1 m/s for shots 147 and 149, respectively.

D. Constitutive Data and Error Analysis for Copper

Figures 23 - 29 for copper are to be found on pages 59 - 65. They show particle velocity, total and plastic strains, normal stress, and deviatoric stress plotted versus time; deviatoric stress plotted versus plastic strain; and plastic strain rate plotted versus plastic strain and deviatoric stress. Tables 12 - 15 give parameter variations, material properties, and shot information.

Quantity	Std. Value	Change, Exp. Range ($qnty. \div std.$)	$\tau_p/\tau_p(std.)$	$\tau_e/\tau_e(std.)$
D($cm/\mu s$)	0.4052	1.→1.0025	1.→1.09	1.→1.57
$\lambda(kbar)$	1077.	0.9935→1.007	1.10→0.89	1.52→0.48
$\mu(kbar)$	443.2	0.977→1.024	1.07→0.91	1.48→0.52
$(B')_T$	5.28	0.95→1.06	1.02→0.96	1.35→0.70
$(\mu')_T$	1.3	1.→0.85	1.→1.008	1.→1.000
$v_c(m/s)$	5.77	1.0→1.15	1.→1.02	1.→1.17

Table 12: Parameter Variations for shot H801 of Cu.

Material	Density (g/cm^3) ρ_a	*Lamé* Constant (Mbar) λ	Shear Modulus (Mbar) μ	$(dB/dP)_T$ $(B')_T$	$(d\mu/dP)_T$ μ'	dB/dT (kbar/K)
Cu	8.937[23]	1.077[34]	0.443[40]	5.28[34]	1.30[40]	-0.22[23]

Table 13: Material Properties for Cu

Material	$d\mu/dT$ (kbar/K)	Grüneisen constant γ	Heat capacity (cal/g K) C_p	Linear expansion K^{-1} α
Cu	-0.20[23]	1.99[1]	0.092[44]	1.65x10^{-5} [45]

Table 14: Material Properties for Cu

Shot I.D.	Normal Stress (kbar)	Sample Thickness (mm)
H800	30	9.970[32]
H801	30	19.939[32]
H802	30	29.959[32]
54 kbar	54	6.36-[1]

Table 15: Plate-Impact Shots for Cu

The material for both Warnes's 30-kbar series[32] and the 54-kbar profile from Sandia[1] is OFE copper, annealed, at least for Warnes's work.

The data points in the data base for the 54-kbar shot are based on actual data points, corrected for window effects, however.

The data points here for the 30-kbar series of Warnes are taken from the final initial condition of the wave code calculation (the one that accurately matched the data when run through the window or free surface). The beginning times for the profiles are arbitrary. The actual data were available and were used at the start of the iterations as an initial condition and for the comparison between the calculation and the data at the free surface.

The error analysis was done for the 30-kbar shot H801 of Warnes.

Data for all the 54-kbar shot were taken through a sapphire window. The 30-kbar series was taken from the free sample surface.

No absolute-timing measurements were made for the shock-wave speed when the VISAR data were taken. Values for the shock speed were taken from the U_s - U_p relation of Munson and Barker:[33] $D = 0.3917 cm/\mu s + 1.520 U_p$, based on absolute measurements but using pre-VISAR technology. To test sensitivity of the results to D, a plausible upward variation of .25% was made.

A great number of values for B were available in the literature, including those of van't Klooster et al.,[34] Hiki and Granato,[35] Chang and Himmel,[36] Schmunk and Smith,[37] Overton and Gaffney,[38] and Goens and Weerts.[39] They all agreed fairly closely, giving a range for λ of 1.07-1.085 Mbar, (using the μ value of van't Klooster to compute λ from B.) The fairly recent value 1.077 from van't Klooster et al.[34] was chosen to be standard since it was from a polycrystal. The range for λ quoted above was 0.9935-1.007 times the standard value. The λ-parameter variation was based on this range.

Only two seemingly good values for μ measured from polycrystals were available: 443.2 kbar from Trappeniers et al.[40] and 454 kbar from Kanemochi et al.[8] The value from Trappeniers was taken as standard. The Kanemochi value is 1.02 times the standard value. The parameter variation made for μ was based on these two values.

A variety of closely agreeing values for $(B')_T$ were available from van't Klooster et al.,[34] Hiki and Granato,[35] Salama and Alers,[41] and Daniels and Smith.[42] $(B')_T$ is the same for cubic single crystals and for polycrystals. The range encountered was 5.3-5.6, a 6% variation. The parameter variation for $(B')_T$ was slightly expanded from this range. The standard value used was that of van't Klooster.

The only values of $(\mu')_T$ available for polycrystals were those of Trappeniers et al.[40] (1.3) and Birch[43] (1.27), differing by about 2%. The former was taken as standard. The parameter variation is larger than this spread in values.

The value of -4 Mbar was used as standard for ζ. Variation of ζ that maintained ν and ξ less than 5 Mbar in magnitude produced very little variation in the results for τ.

The values of $\tau(1st)_p/\tau_p$ and $\tau(1st)_e/\tau_e$ for the shot H801 were 0.92 and 0.52, respectively. It appears that the second order thermoelastic expansion is working reasonably well here.

The values used for v_c were 5.61, 5.77, 5.81, and 10.85 m/s for shots H800, H801, H802, and 54 kbar, respectively.

E. Constitutive Data and Error Analysis for Iron

Figures 30 - 36 for iron are to be found on pages 66 - 72. They show particle velocity, total and plastic strains, normal stress, and deviatoric stress plotted versus time; deviatoric stress plotted versus plastic strain; and plastic strain rate plotted versus plastic strain and deviatoric stress. Tables 16 - 19 give parameter variations, material properties, and shot information.

Quantity	Std. Value	Change, Exp. Range ($qnty. \div std.$)	$\tau_p/\tau_p(std.)$	$\tau_e/\tau_e(std.)$
D(cm/μs)	0.4978	1.→1.004	1.→1.04	1.→1.20
$\mu(kbar)$	814.7	1.→0.997	1.→1.0	1.→1.0
$(B')_T$	5.463	0.94→1.09	1.02→0.97	1.2→0.94
$(\mu')_T$	1.857	1.→1.03	1.→1.0	1.→1.0
$v_c(m/s)$	[illegible].3	1.→1.12	1.→1.04	1.→1.08
$\zeta(Mbar)$	-5.5	-10.→20. abs. values	1.0→1.1	1.0→1.2

Table 16: Parameter Variations for shot Fe15.

Material	Density (g/cm^3) ρ_a	*Lamé* Constant (Mbar) λ	Shear Modulus (Mbar) μ	$(dB/dP)_T$ $(B')_T$	$(d\mu/dP)_T$ μ'	dB/dT (kbar/K)
Fe	7.85[16]	1.1236[51]	0.8147[51]	5.463[51]	1.857[51]	-0.33[52]

Table 17: Material Properties of Fe

The material used for the shock experiments was ARMCO iron of 99.8% purity and with an average grain size of 150μm.[16] The material was used as received. It had a Rockwell hardness of B 34 to 37. The experiments were done nominally at room temperature.

Material	$d\mu/dT$ (kbar/K)	Grüneisen constant γ	Heat capacity (cal/g K) C_p	Linear expansion K^{-1} α
Fe	-0.294[52]	1.7[53]	0.107[54]	1.18x10^{-5} [55]

Table 18: Material Properties of Fe

Shot I.D.	Normal Stress (kbar)	Sample Thickness (mm)[16]
15	105	6.304
16	131	6.309

Table 19: Plate-Impact Shots for Fe

The data points in the data base correspond to actual data points. The velocity profiles given here are the ones obtained from Sandia. They have been corrected slightly for window reflection effects.

The data were taken through a sapphire window.

Shock velocities (measured by absolute timing) and particle velocity profiles were measured along with the profiles by Barker and Hollenbach.[16] The values for D used here were taken from their $U_s - U_p$ fit: $D = 0.463 cm/\mu s + 1.33 U_p$. The sensitivity of the results to D for shot Fe15 was assessed by raising the value for D from this relation by 0.4%.

All parameter variations for Fe were done for shot Fe15.

A $U_s - U_p$ relation from experimental work by Arnold and Sachs[46] produced a plastic wave velocity differing by 2% from the standard one used here for shot Fe15. This value yielded very small τ_e values of about 0.5 kbar.

Three sets of high-quality elastic constant data including pressure derivatives are available, from Voronov and Vereshchagin,[22] Rotter and Smith,[47] and Guinan.[48] The quoted values were 1,667, 1,669, and 1,664 kbar for B; 812, 818, and 814 kbar for μ; 5.13, 5.96, and 5.29 for $(B')_T$; and, finally, 2.16/1.84, 1.91, and 1.82 for $(\mu')_T$; all for Voronov, Rotter and Smith, and Guinan, respectively. The slash for the Voronov $(\mu')_T$ value indicates two conflicting values to be found in their paper.[22] These values all agree fairly well. Their averages were used for the database calculation (using 1.84 for the Voronov value for $(\mu')_T$). The parameter variations used in the error analysis for these quantites are based on the experimental spread. The experimental values for B were so close together, a spread of 0.3%, that no parameter variation was done for this quantity. The above experimental spread in μ-values is 0.7%; that for $(B')_T$ is about 15%; while that for $(\mu')_T$ is about 5%.

The complete sets of TOE available from Hughes and Kelley[49] and Seeger and Buck[50] were not used here. They yielded $(B')_T$ values of 2.8 and 4.0, respectively, which differ significantly from those above.

The standard value for ζ was taken to be -5.5 Mbar. As ζ was varied from -10 Mbar to 20 Mbar, ν, the larger in magnitude of ν and ξ, varied from 49.8 Mbar to -260 Mbar. The former value produced little change in the calculated τ values, while the latter resulted in an increase in all τ of less than 20%. This parameter variation, the one quoted in Table 16, goes far outside the physical range.

The sensitivity of the results to a different precursor treatment was assessed. It was assumed that the wave-portion between points b and c, i.e. between the elastic rise and the steady wave, propagated as a simple wave, i.e. that the propagation velocity at constant particle velocity depended only on particle velocity. The propagation velocity was interpolated using the particle velocities between the elastic precursor propagation velocity and the plastic-wave velocity. This change in treatment resulted in τ_p and τ_ε dropping to 0.93 and 0.83 of their former values, i.e. no large change was seen.

The values of $\tau(1st)/\tau$ for shot Fe15 for the peak and end deviatoric stresses were 0.89 and 0.52. respectively.

The point b of the Wallace analysis was changed for shot Fe15 from 1.10 μs to 1.07 μs to assess the sensitivity of the results to the choice for this point. The plot for $\dot{\psi}$ versus τ underwent very little change to the eye, i.e. less than 1% change.

The values used for v_c were 35.3 and 43.2 m/s for shots Fe15 and Fe16, respectively.

Some comment is in order concerning Fig. 36, where the strain rate drops to the x-axis in the precursor portion of the stronger shock in Fig. 36, where $log(\dot{\psi})$ is plotted versus τ. This drop is due to the corresponding dip seen in Fig. 30 in the plot of particle velocity versus time. This dip gives rise to a short negative strain rate excursion. In the plots, all strain rates less than 1/s were set equal to 1/s. Hence, the negative strain rate excursion is reproduced there as a portion lying on the x-axis.

F. Constitutive Data and Error Analysis for 21-6-9 Stainless Steel

Figures 37 - 43 for 21-6-9 stainless steel are to be found on pages 73 - 79. They show particle velocity, total and plastic strains, normal stress, and deviatoric stress plotted versus time; deviatoric stress plotted versus plastic strain; and plastic strain rate plotted versus plastic strain and deviatoric stress. Tables 20 - 23 give parameter variations, material properties, and shot information.

Quantity	Std. Value	Change, Exp. Range ($qnty. \div std.$)	$\tau_p/\tau_p(std.)$	$\tau_e/\tau_e(std.)$
$D(cm/\mu s)$	0.4783	1.→0.9967	1.→0.97	1.→0.93
$\lambda(kbar)$	998.	1.→1.067	1.→0.88	1.→0.48
$\mu(kbar)$	786.	1.→0.985	1.→0.88	1.→0.48
$(B')_T$	5.57	1→0.97	1.→1.007	1.→1.06
$(\mu')_T$	1.75	1.→1.07	1.→1.007	1.→1.06
$v_c(m/s)$	47.0	1.→0.89	1.→0.97	1.→0.95
$\zeta(Mbar)$	-4.	-5.5→-3. abs. values	1.→1.01	1.→1.02

Table 20: Parameter Variations for Shot SSWP1S for SS. B, μ and $(B')_T$, $(\mu')_T$ were varied jointly.

Material	Density (g/cm^3) ρ_a	*Lamé* constant (Mbar) λ	Shear modulus (Mbar) μ	$(dB/dP)_T$ $(B')_T$	$(d\mu/dP)_T$ $(\mu')_T$	dB/dT (kbar/K)
21-6-9SS	7.822[5]	0.998[5]	0.786[5]	5.57[56]	1.75[56]	-0.14[57]

Table 21: Material Properties for 21-6-9 SS

Material	$d\mu/dT$ (kbar/K)	Grüneisen constant γ	Heat capacity (cal/g K) C_p	Linear expansion K^{-1} α
21-6-9 SS	-0.37[57]	1.67[56]	0.11[58]	$1.71\text{x}10^{-5}$ [59]

Table 22: Material Properties for 21-6-9 SS

Shot I.D.	Normal Stress (kbar)	Sample Thickness (mm)[5]
SSWP1S	98	4.175

Table 23: Plate-Impact Shots for 21-6-9 SS

The material used for the VISAR shots was nominally 21-6-9 stainless steel (SS) with the following composition (wt. %): Cr(19.81), Ni(7.23), Mn(9.38), N_2(0.30), C(0.02), P(0.011), S(0.010), and Si(0.09) with the balance Fe.[5] The average grain size was $80\mu m$[5] after annealing.

The data points here for 21-6-9 SS are taken from the last initial condition of the wave code calculation, the one that accurately matched the data when run through the window. The actual data were available and were used at the start of the calculation and for the data-calculation comparison at the free surface. Thus, the particle velocity profile given in this database has been corrected for effects of the sapphire window.

Only the shot SSWP1S was analyzed for the database. The others lacked resolution through the shock rise.

Absolute timing measurements were made of shock velocities at the same time as the particle velocity profiles were measured.[5] Wise fitted his shock velocities with the $U_s - U_p$ relation: $D = 0.4403 cm/\mu s + 1.441 U_p$. The D given by this expression for shot SSWP1S is 0.9967 of that directly measured for this shot, which was taken as standard in the database calculation. This variation is the one taken for the parameter-variation calculations as representing the error in the measured shock velocity.

Wise and Mikkola measured ultrasonic sound velocities from which the standard values for λ and μ were taken for the database calculation. Measured polycrystalline pressure derivatives for a number of stainless steels closely related to 21-6-9 SS are given by Gerlich and Hart.[56] The $(B')_T$ and $(\mu')_T$ values for 304 SS given there are taken here as standard since this SS is closest to 21-6-9 SS in composition. The pressure derivatives of 316 SS, another similar steel, were used in the parameter variations to give some idea of the uncertainty due to $(B')_T$ and $(\mu')_T$. These values for $(B')_T$ and $(\mu')_T$ were 0.97 and 1.07 times those of 304 SS used as standard. The λ and μ values of the 304 SS were used in the parameter variations of the error analysis. These values for λ and μ were 1.067 and 0.985 times the standard ones measured for 21-6-9 SS by Wise and Mikkola.[5]

The major constituents of the 304 SS investigated by Gerlich and Hart are (besides Fe)(wt. %): Cr(18.4), Ni(9.7), Mn(1.4), and Mo(0.0). Those of their 316 SS are: Cr(16.8), Ni(11.7), Mn(1.9), and Mo(2.1).

The ζ-value -4. Mbar was taken as standard. Varying ζ over the range -5.5→-3. Mbar produced the variation in ν from -10.74 to 11.76 Mbar. The TOE-ξ was smaller in magnitude. This ζ-range is thus the physical one, and was, therefore, used in the parameter variations.

The values for $\tau(1st)_p/\tau_p$ and $\tau(1st)_\epsilon/\tau_\epsilon$ for this SS shot were 0.90 and 0.66, respectively.

The value of v_b was changed to 0.87 of its standard value to assess the sensitivity of the data analysis to the choice for v_b. τ_p and τ_e changed to 0.97 and 0.94 of their standard values, respectively.

G. Constitutive Data and Error Analysis for Uranium

Figures 44 - 50 for uranium are to be found on pages 80 - 86. They show particle velocity, total and plastic strains, normal stress, and deviatoric stress plotted versus time; deviatoric stress plotted versus plastic strain; and plastic strain rate plotted versus plastic strain and deviatoric stress. Tables 24 - 27 give parameter variations, material properties, and shot information.

Quantity	Std. Value	Change, Exp. Range ($qnty. \div std.$)	$\tau_p/\tau_p(std.)$	$\tau_e/\tau_e(std.)$
D($cm/\mu s$)	0.2735	1.→0.9978	1. →0.99	1.→0.96
$\lambda(kbar)$	526.67	1.→0.93	1.→1.12	1.→1.23
$\mu(kbar)$	860.	1.→0.97	1.→1.04	1.→1.09
$(B')_T$	5.95	1→0.96	1.→1.0	1.→1.04
$(\mu')_T$	2.99	1.→1.05	1.→1.0	1.→1.0
$v_c(m/s)$	31.0	1.0→1.14	1.0→1.04	1.0→1.04
$\zeta(Mbar)$	-5.5	-5.5→0.0 abs. values	1.0→1.02	1.0→1.03

Table 24: Parameter Variations for shot AV10 for U. v_c is *in situ*.

Material	Density (g/cm^3) ρ_a	*Lamé* constant (Mbar) λ	Shear modulus (Mbar) μ	$(dB/dP)_T$ $(B')_T$	$(d\mu/dP)_T$ $(\mu')_T$	dB/dT (kbar/K)
U	18.940[61]	0.52667[61]	0.860[61]	5.95[61]	2.99[61]	-0.10[23]

Table 25: Material Properties for U

Material	$d\mu/dT$ (kbar/K)	Grüneisen constant γ	Heat capacity (cal/g K) C_p	Linear expansion K^{-1} α
U	-0.5[23]	1.56[1]	0.02772[62]	1.39x10^{-5} [63]

Table 26: Material Properties for U

Shot I.D.	Normal Stress (kbar)	Sample Thickness (mm)[60]
AV6	75	7.539
AV10	96	7.565
AV8	116	7.530
AV7	127	7.624
AV9	144	7.640

Table 27: Plate-Impact Shots for U

The material used for the uranium shock-wave measurements was unalloyed D-38 from Union Carbide.[60]

The data points for U in the data base are based on the actual free-surface profile data multiplied by one-half and linearly interpolated to fill out the raw data points to serve as a better initial condition for the wave-code calculation. (The data were in no way sparse, however.) The constitutive data are the result of the Wallace analysis done on this initial condition. The agreement between the free surface data and this initial condition after being run to the free surface using the power-law fit to the constitutive data was good for the first half of the shock rise and fair for the second half for the five velocity profiles analyzed. See the section on the method of data reduction for more information.

Absolute timing measurements were not done during the shock profile measurements. The shock velocites were calculated in the original work[60] by using an average precursor velocity and relative times between the precursor rise and the plastic wave front. Grady fitted the following $U_s - U_p$ relation to the shock velocities: $D = 0.249 cm/\mu s + 1.370 U_p$.

For the error analysis, the analysis for shot AV10 was used. The standard shock velocity for this shot was taken to be that given by the $U_s - U_p$ relation. To test the sensitivity of the data analysis to D, this value was varied to the actual measured velocity for this shot.

The only set of polycrystalline elastic constants with pressure derivatives found was that of Abey and Bonner.[61] Their values were varied by plausible amounts in the error analysis.

The ζ-value of -5.5 Mbar was taken as standard. Varying it to zero resulted in ν, the larger of the other two TOE in magnitude, changing from 20.3 to -29.2 Mbar. Hence, the interval -5.5 to 0 Mbar for ζ includes the physically reasonable choices.

When v_b was lowered to 0.87 of its standard value, τ_p and τ_e both changed to 0.97 of their standard values.

The values for shot AV10 for $\tau(1st)_p/\tau_p$ and $\tau(1st)_e/\tau_e$ are 0.85 and 0.65. The second-order thermoelastic expansion seems to be adequate here.

The values used for v_c were 29.09, 31.04, 28.95, 35.47, and 34.48 m/s for shots AV6, AV10, AV8, AV7, and AV9, respectively.

H. Constitutive Data and Error Analysis for Vanadium

Figures 51 - 57 for vanadium are to be found on pages 87 - 93. They show particle velocity, total and plastic strains, normal stress, and deviatoric stress plotted versus time; deviatoric stress plotted versus plastic strain; and plastic strain rate plotted versus plastic strain and deviatoric stress. Tables 28 - 31 give parameter variations, material properties, and shot information.

Quantity	Std. Value	Change, Exp. Range ($qnty. \div std.$)	$\tau_p/\tau_p(std.)$	$\tau_e/\tau_e(std.)$
D(cm/μs)	0.529	1.→0.99	1. →1.0	1.→1.01
$\lambda(kbar)$	1258.0	1.→0.986	1.→1.02	1.→1.14
$\mu(kbar)$	471.6	1.→1.04	1.→1.02	1.→0.96
$(B')_T$	4.74	0.9→1.1	0.99→1.00	1.10→0.90
$(\mu')_T$	0.516	1.→0.9	1.→1.0	1.→1.0
$v_c(m/s)$	61.7	1.→1.1	1.→1.05	1.→1.06
$\zeta(Mbar)$	-4.	-5.→-2. abs. values	$\pm 6\% change$	$\pm 6\% change$

Table 28: Parameter Variations for shot VAN2 for V

Material	Density (g/cm^3) ρ_a	*Lamé* constant (Mbar) λ	Shear modulus (Mbar) μ	$(dB/dP)_T$ $(B')_T$	$(d\mu/dP)_T$ $(\mu')_T$	dB/dT (kbar/K)
V	6.08[6]	1.2580[6]	0.4716[6]	4.74[65]	0.516[65]	-0.119[66]

Table 29: Material Properties for V

Material	$d\mu/dT$ (kbar/K)	Grüneisen constant γ	Heat capacity (cal/g K) C_p	Linear expansion K^{-1} α
V	-0.084[64]	1.35[66]	0.116[67]	0.84×10^{-5} [68]

Table 30: Material Properties for V

Shot I.D.	Normal Stress (kbar)	Sample Thickness (mm)[6]
VAN2	64	5.052
VAN3	97	5.047

Table 31: Plate-Impact Shots for V

The material used for the shock wave studies was 99.9% pure with a range in grain size of 30 – 150μm.[6]

The data points here for vanadium were digitized from Fig. 5 of the original paper,[6] in which window-corrected velocity profiles were given.

The shock profile data were taken through a sapphire window.

Shock wave velocities were calculated by Chhabildas and Hills[6] using an average velocity of the leading wave edge together with measured relative times between this edge and the plastic wave front. The sensitivity of the data analysis to D for shot VAN2 was assessed by lowering the measured D by the plausible amount of 1%.

The analysis of shot VAN2 was used in the error analysis.

Sources for polycrystalline elastic constants were ultrasonic measurements by Chhabildas and Hills[6] and Farraro and McLellan.[64] Alberts et al.[65] give measurements for two single crystals from which Voigt and Reuss averages were calculated by the author. The average of the Voigt and Reuss values was taken for consideration here. The λ and μ values of Chhabildas et al. were taken as standard, since they were done on the same material shot. The λ-values of Farraro et al. and of one of the two crystals of Alberts were lower than the standard value by 0.5%. The other of the two crystals of Alberts was higher by 0.3%. For the error analysis, the standard λ-value was lowered by 1.4%, which should adequately represent the range of values available.

The μ-value of Farraro and McLellan was 2% lower than the standard, while the two values from Alberts were 1% and 1.5% higher. For the error analysis, μ was varied up from the standard value by 4%.

Pressure derivatives of μ were available only from the Voigt and Reuss averages (done by the author) of Alberts's data for the two single crystals. Values for $(\mu')_T$ for each crystal were obtained by averaging the Voigt and Reuss values for that crystal. The standard value for $(\mu')_T$ for use in analyzing the wave profiles was obtained from the average of the corresponding values for the two crystals. For the $(\mu')_T$-variation of the error analysis, the standard value was varied downward by 10%, to the lower of the two values of the single crystals.

For $(B')_T$, the standard value was taken to be the average of those for the single crystals. For the error analysis, the standard value for $(B')_T$ was varied by about $\pm 10\%$, which reflected the variation of the $(B')_T$-values for the two crystals from the standard value.

The ζ-value of -4 Mbar was taken as standard. Varying ζ between -5. and -2. Mbar resulted in a variation in ν between 11.7 and -15.3 Mbar, which includes the physically reasonable values. ν was larger in magnitude than ξ. This same ζ-range was used in the error analysis.

When v_b was varied to 0.89 of its standard value, τ_p and τ_r dropped to 0.95 and 0.93 of their standard values, respectively.

The values for shot VAN2 for $\tau(1st)_p/\tau_p$ and $\tau(1st)_e/\tau_e$ were 0.99 and 0.86, respectively. The second-order thermoelastic expansion is thus quite adequate here.

The values used for v_c were 61.7 and 64.6 m/s for shots VAN2 and VAN3, respectively.

An odd feature of Fig. 55, where τ is plotted versus ψ, is worthy of mention. This feature is the pronounced droop in deviatoric stress as the end of the shock wave is approached. This same behavior was noted by Chhabildas,[6] who used a different method to extract the deviatoric stress. This behavior is proabably real and could indicate some sort of thermal softening.

V. Strain-Rate Modeling

In this section power-law fits to the stress-strain rate data will be given. The fits were made only to the plastic-wave part of the shock wave. Except for uranium, no yield stresses were included in the power-law fits. For materials, such as vanadium and iron, which have a high initial yield stress, this omission will result in a different fit but one which can perhaps be more meaningfully compared with the fits for the materials not possessing a large yield strength. In the case of the 30-kbar Cu data and the 21-6-9 SS data, fits were also made for the precursor portion for use in wave code calculations. See the earlier work of Tonks[4] and Warnes and Tonks[32] for these fits.

The algebraic form used for giving the plastic strain rate, $\dot{\psi}$ as a function of ψ and τ is the following:

$$\dot{\psi} = 10^d(\tau - \tau_y - h\psi)^g(\psi + \psi_a)^c, \quad (10)$$

where d, h, g, and c are constants to be fitted. The terms τ_y and $h\psi$ provide zero strain rate at the beginning and ending of the shock. The term ψ_a is a small initial strain included in the fit mostly to give a small initial strain-rate for wave-code calculations. Its value was taken to be .0001 here, small enough to have no effect on the plastic-wave fit.

Table 32 gives the strain-rate-law parameters found from the fits to the data. When these values are used in the power law above, $\dot{\psi}$ and τ have the units of 1/s and Mbar, respectively. The values have a general similarity.

Material	Shot	d	h	g	c
6061T6 Al	937(37 kbar)	25.844	0.055	5.76	1.97
Be	Be18(63 kbar)	13.460	0.04	1.842	1.507
Cu	H801(30 kbar)	18.048	0.0141	2.99	1.18
Cu	54 kbar	21.490	0.0155	4.26	1.188
Fe	Fe15 (105 kbar)	14.530	0.085	2.30	1.45
21-6-9 SS	SSWP1S (98 kbar)	13.596	0.130	2.303	1.278
U	AV10(96 kbar)	16.450	0.045	3.799	0.7768
V	VAN2(64 kbar)	15.894	0.12	2.99	1.405

Table 32: Plastic Wave Strain-rate Parameters, $\tau_y = 4.828$ kbar for U only

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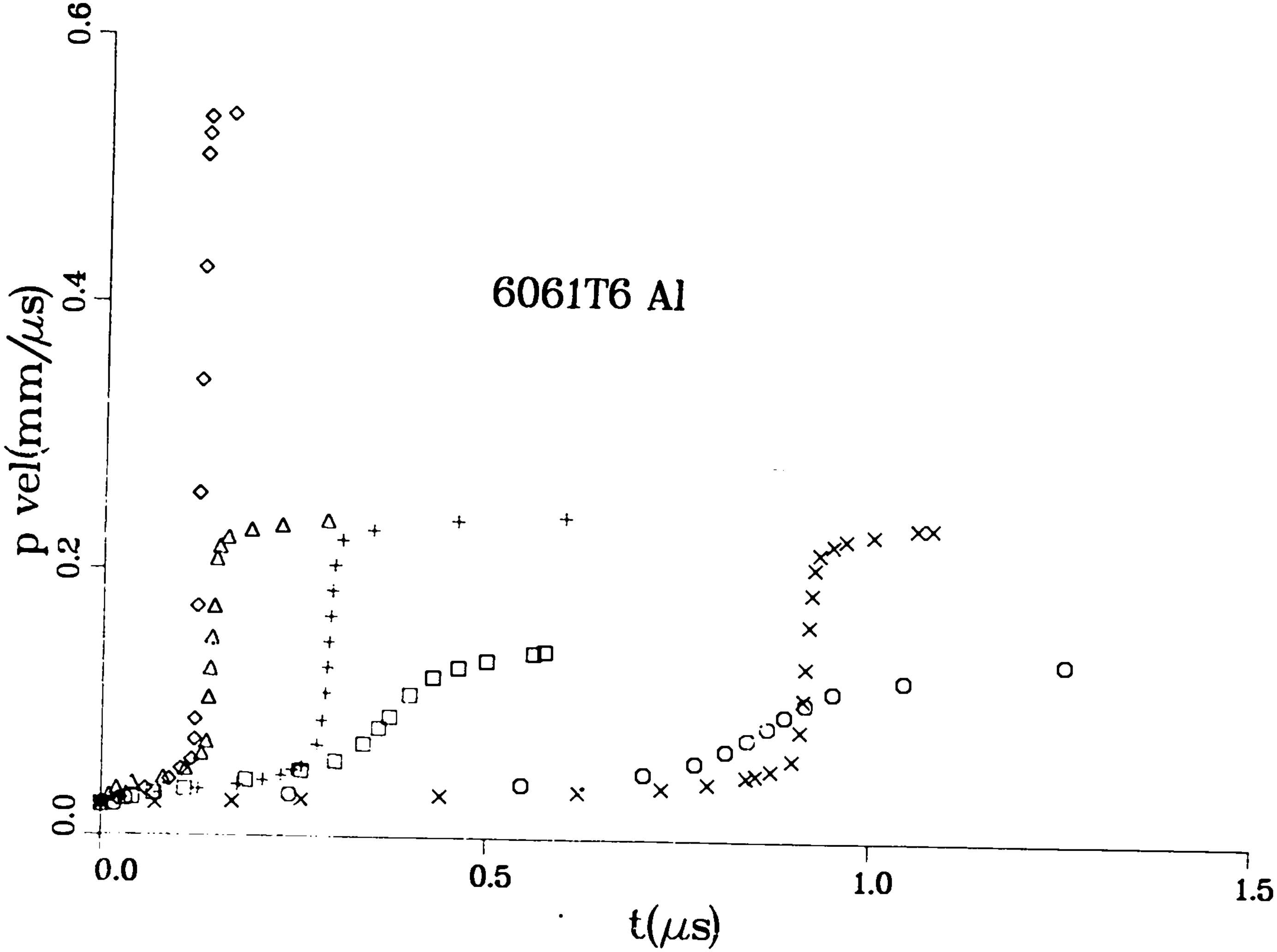

Fig. 2. *In situ* particle velocity versus time for 6061T6 Al. Squares, circles, triangles, crosses, Xs, and diamonds are for shots 922, 939, 936, 927, 937, and 926, respectively.

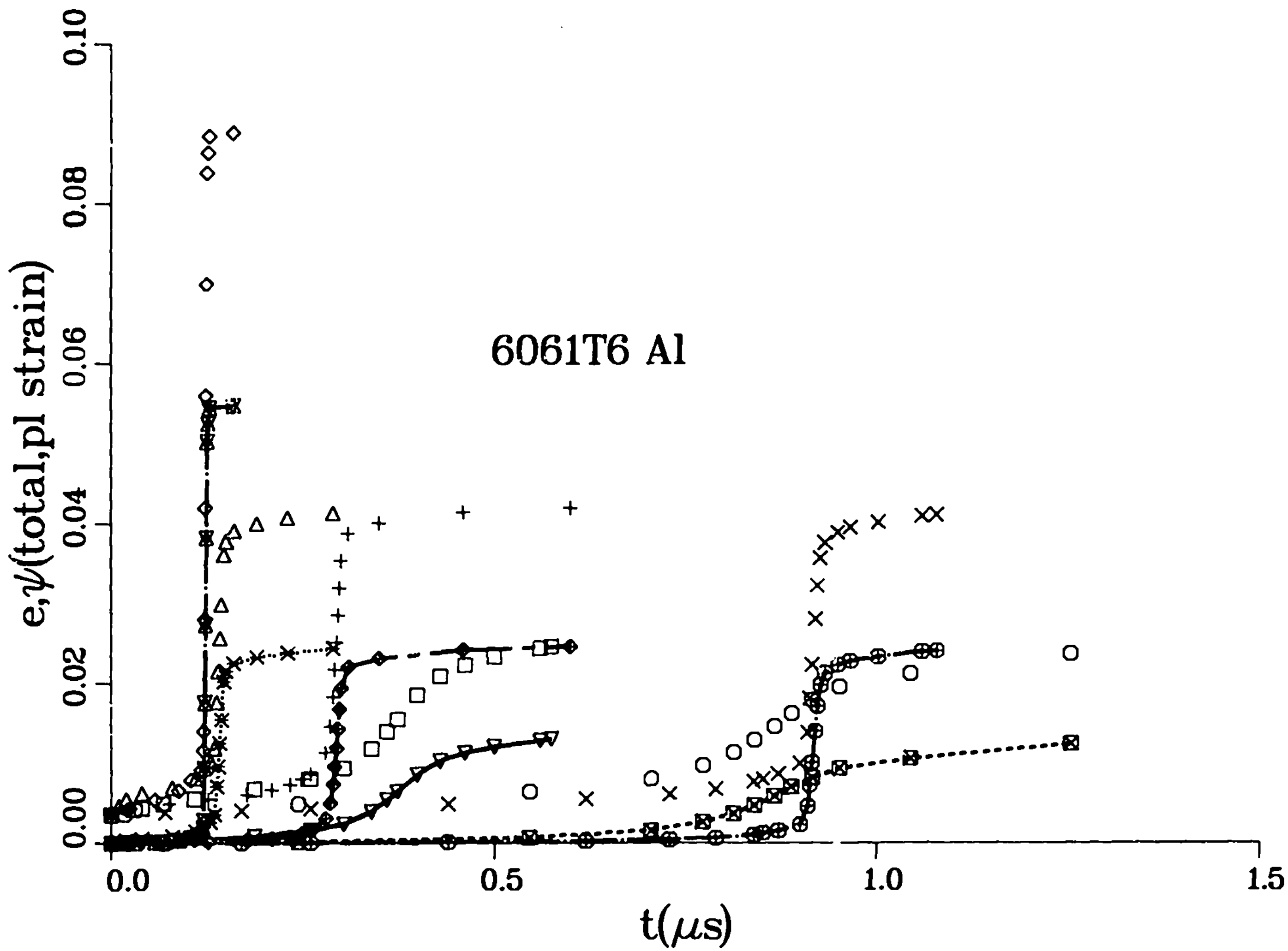

Fig. 3. *In situ* total and plastic strain versus time for 6061T6 Al. Squares, circles, triangles, crosses, Xs, and diamonds are total strains for shots 922, 939, 936, 927, 937, and 926, respectively. Inverted triangles, X'ed squares, crossed Xs, diamond-pluses, circle-pluses, and double Xs are plastic strains for the same sequence of shots. Lines are to guide the eye.

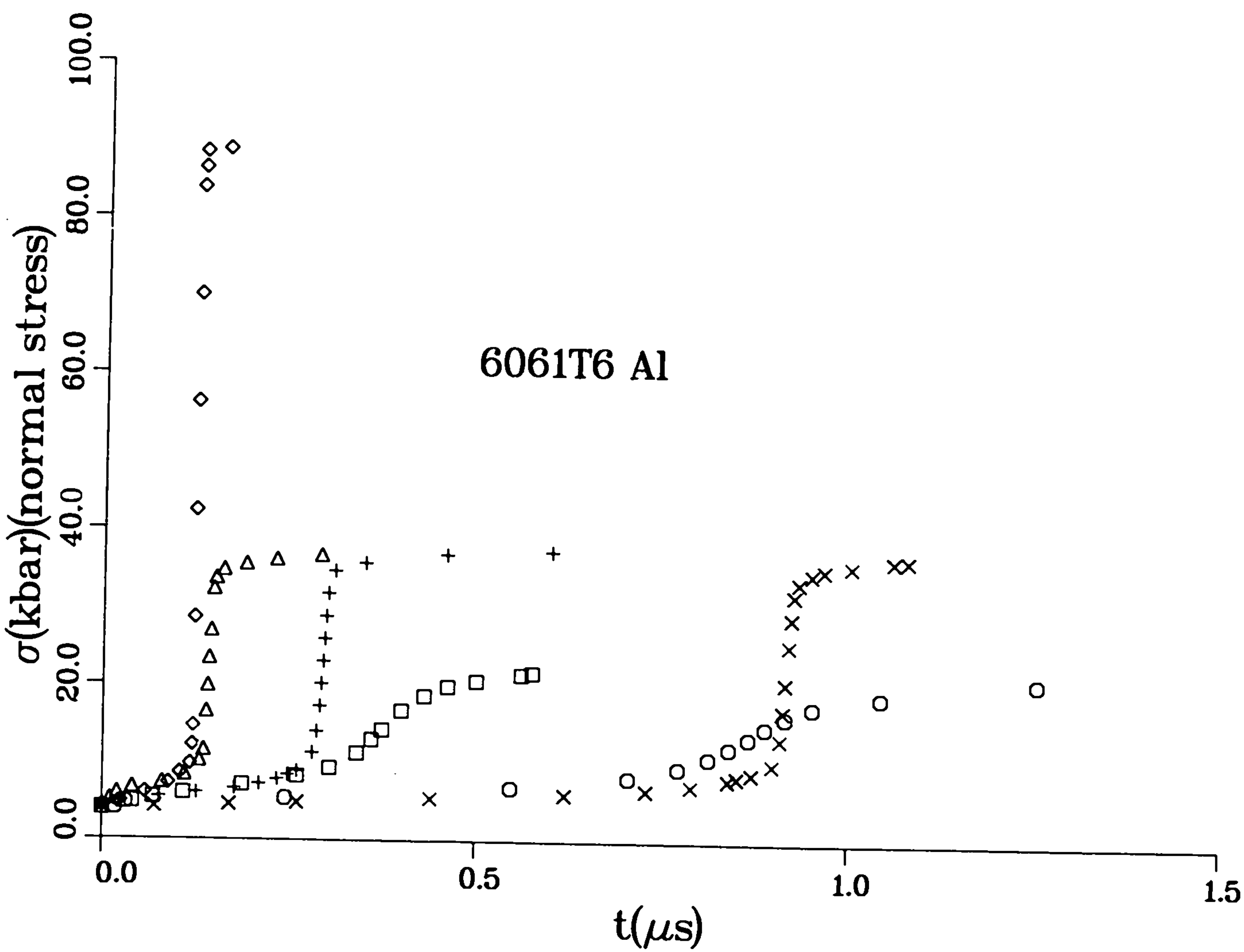

Fig. 4. *In situ* normal stress versus time for 6061T6 Al. Squares, circles, triangles, crosses, Xs. and diamonds are for shots 922, 939, 936, 927, 937, and 926, respectively.

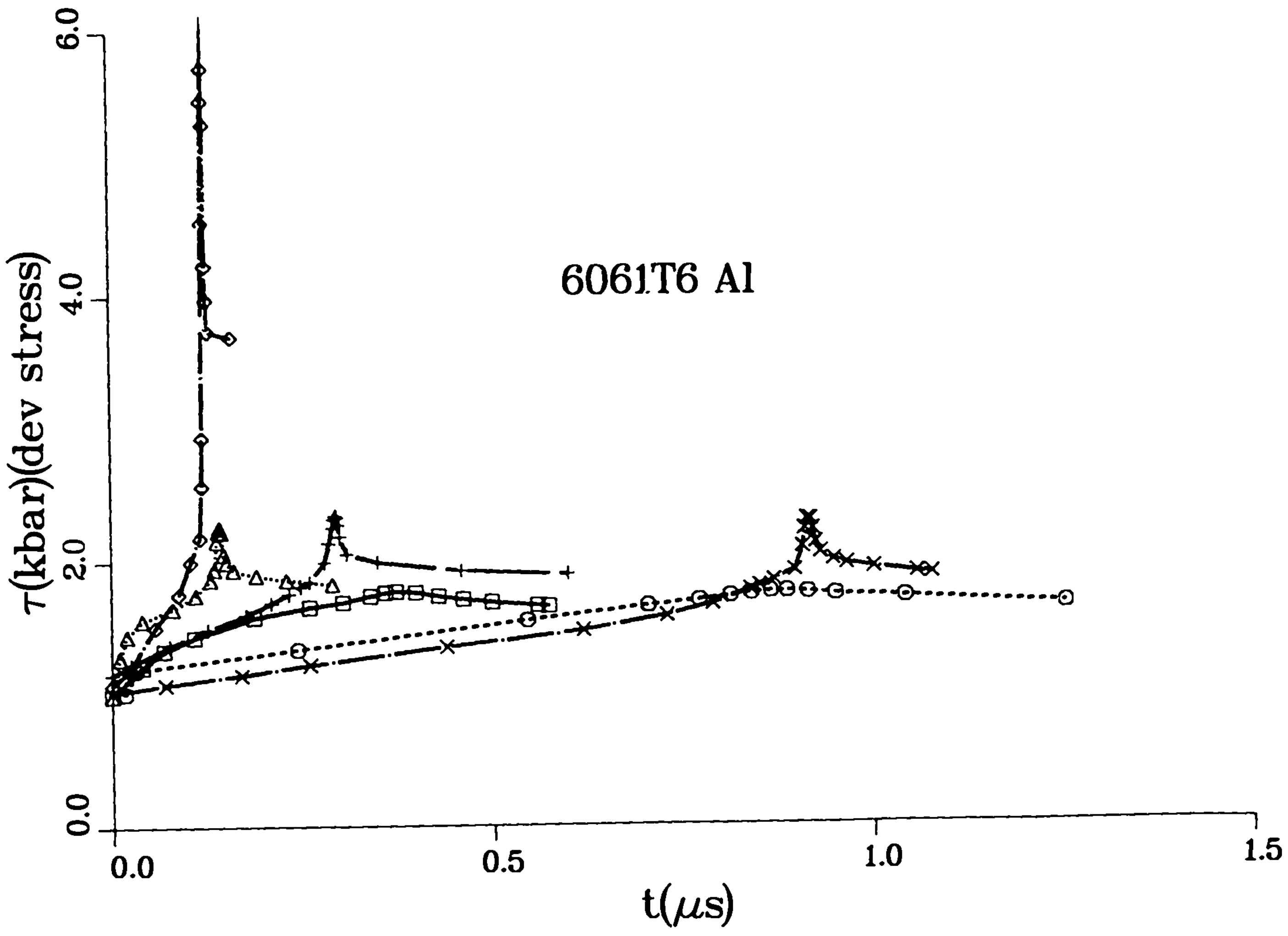

Fig. 5. *In situ* deviatoric stress versus time for 6061T6 Al. Correspondence between symbols and shots same as for Fig. 4. Lines are to guide the eye.

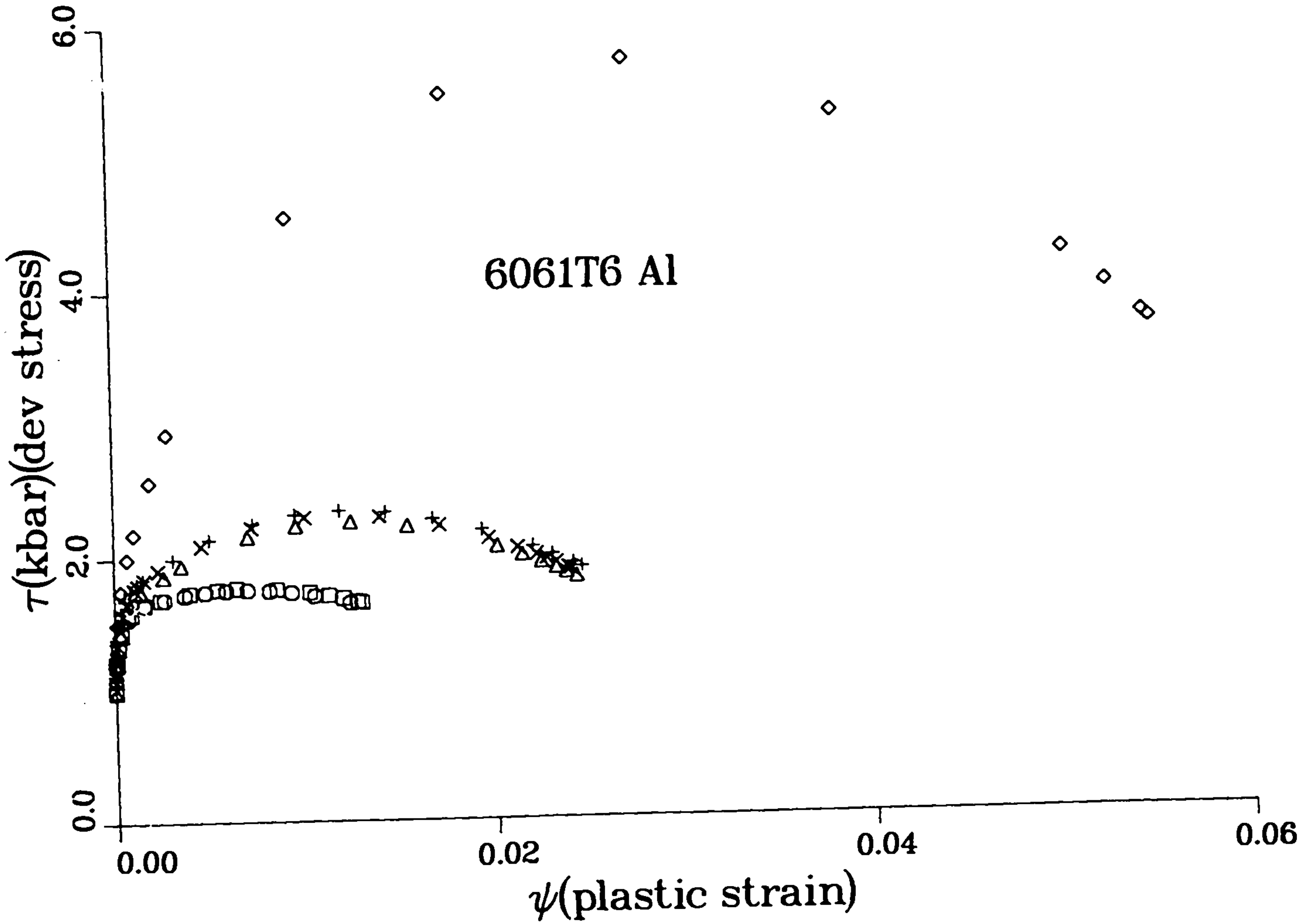

Fig. 6. *In situ* deviatoric stress versus plastic strain for 6061T6 Al. Correspondence between symbols and shots same as for Fig. 4.

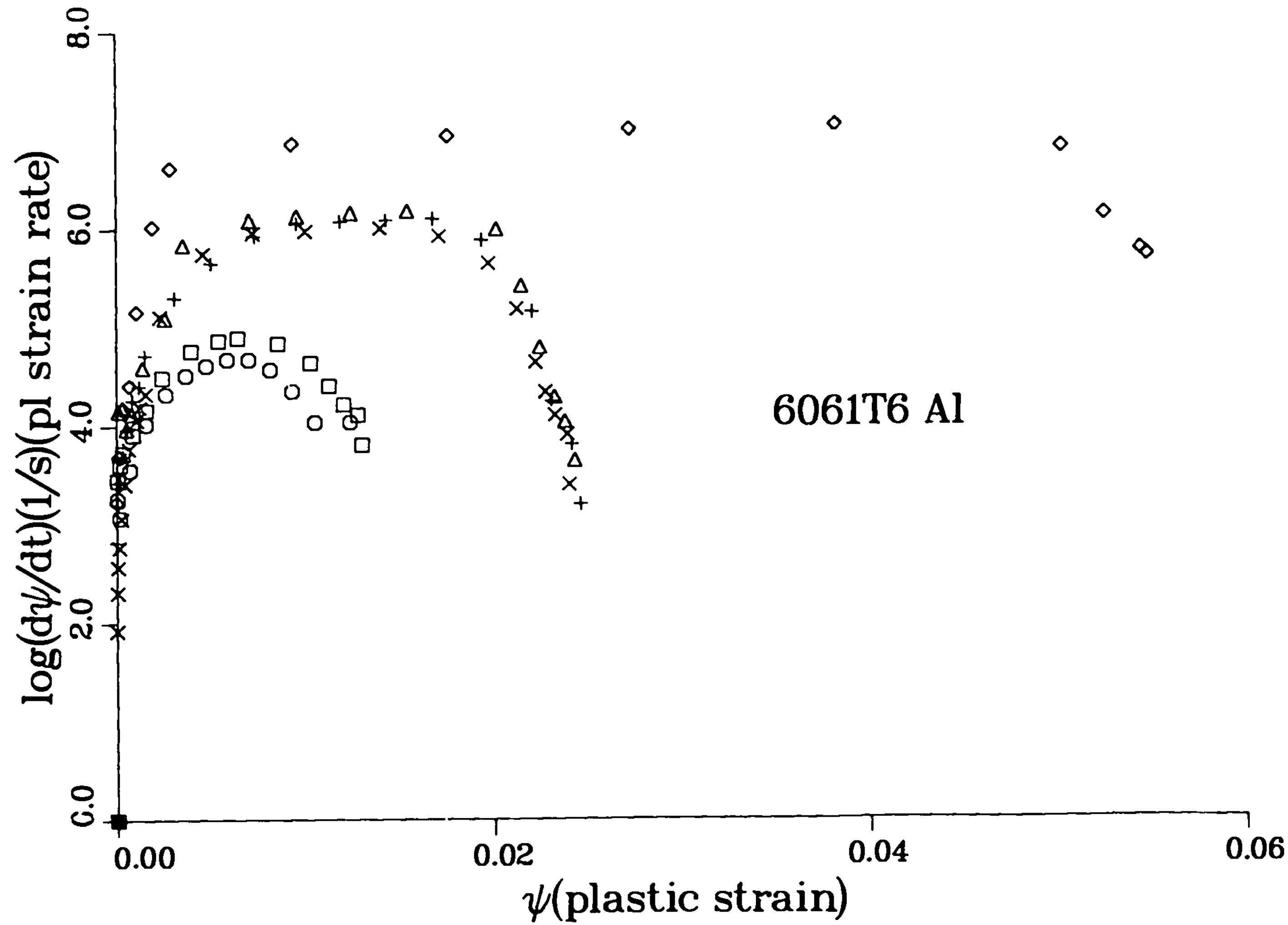

Fig. 7. Log(base 10) of *in situ* plastic strain rate versus plastic strain for 6061T6 Al. Correspondence between symbols and shots same as for Fig. 4.

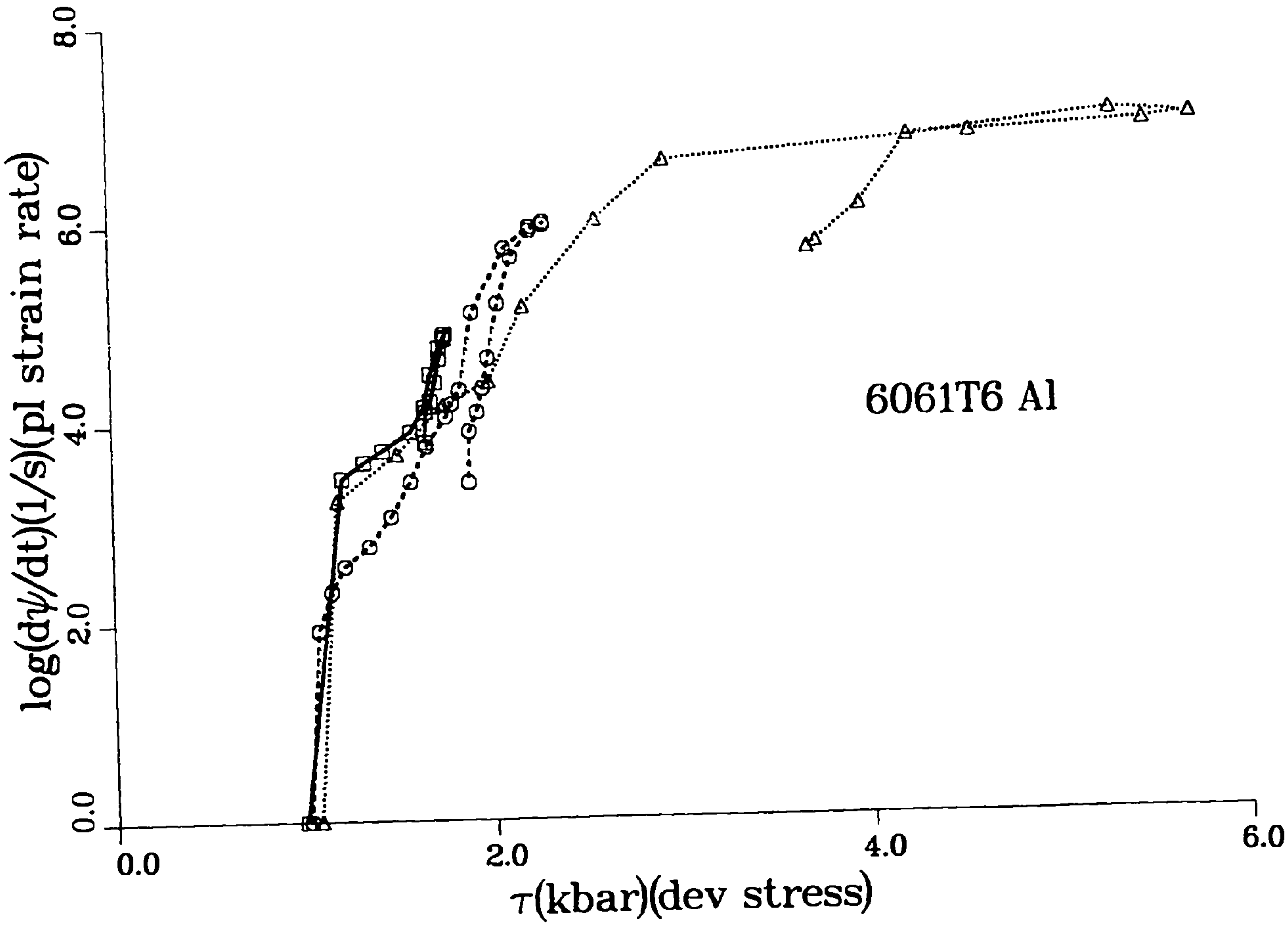

Fig. 8. Log(base 10) of *in situ* plastic strain rate versus deviatoric stress for 6061T6 Al. Squares, circles, and triangles are for shots 922, 937, and 926, respectively. Lines are to guide the eye.

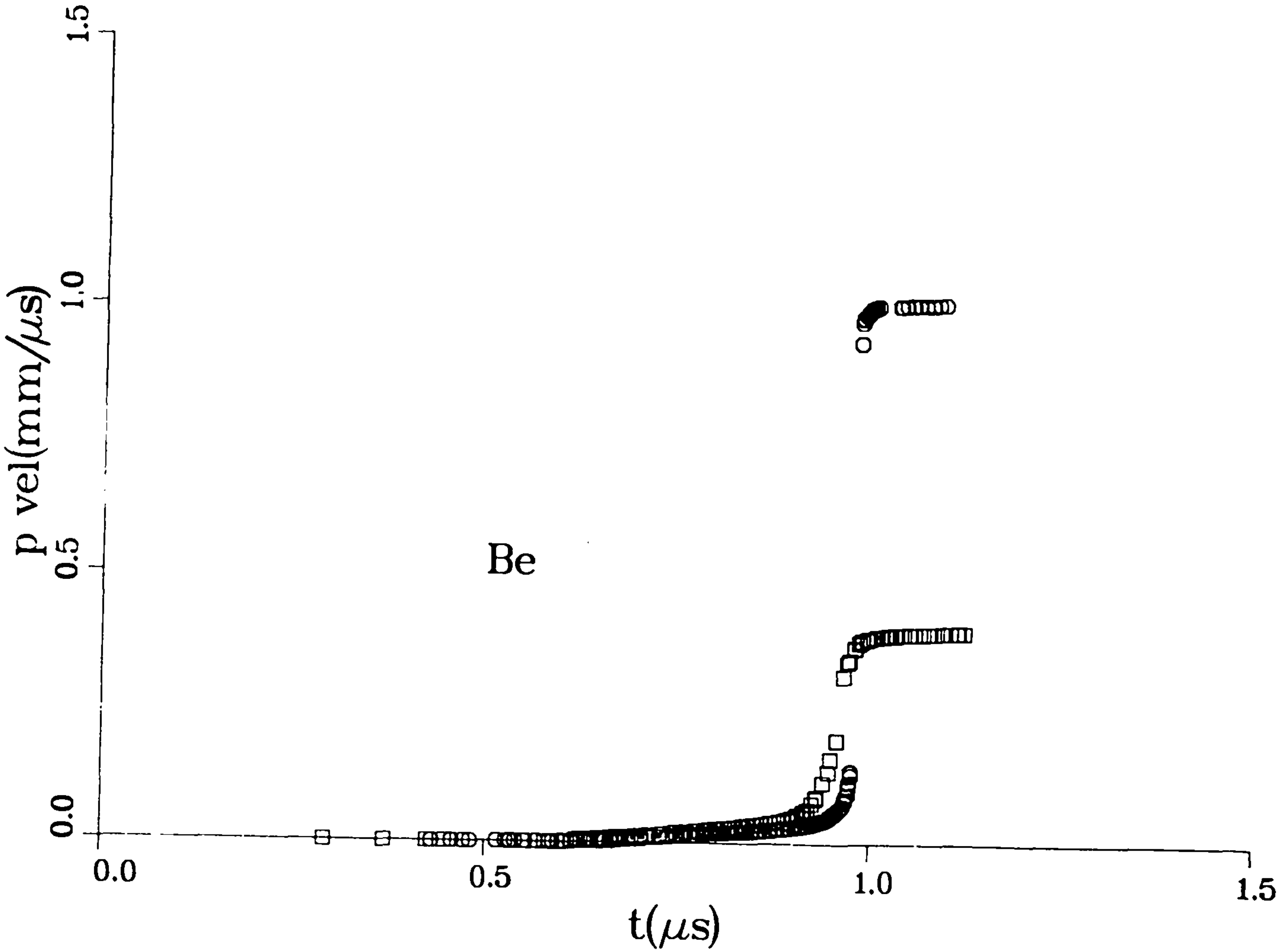

Fig. 9. *In situ* particle velocity versus time for beryllium. Squares and circles are for shots Be18 and Be14, repsectively.

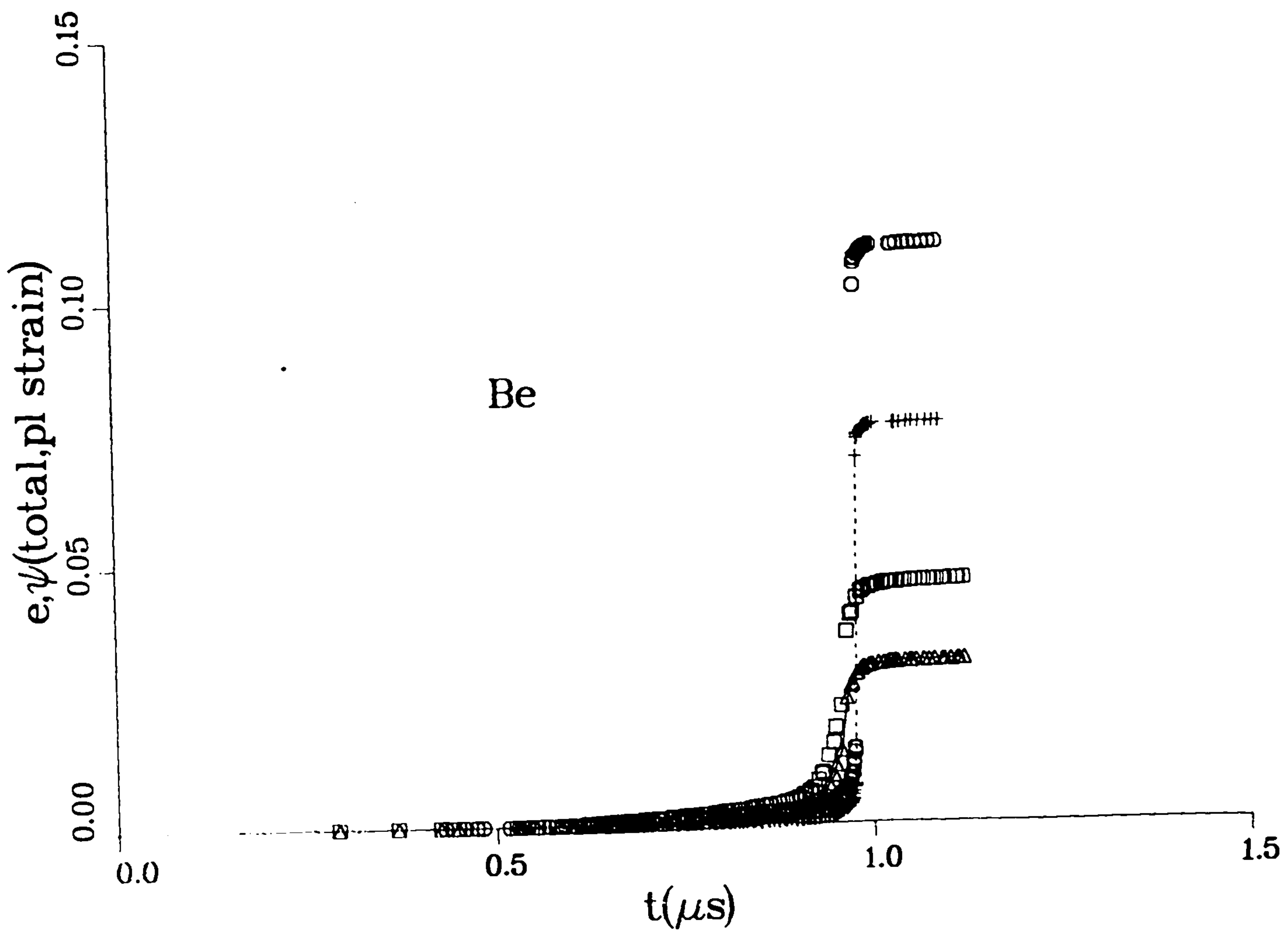

Fig. 10. *In situ* total strain and plastic strain versus time for beryllium. Squares and circles are total strains for shots Be18 and Be14, respectively. Triangles and pluses are plastic strains for shots Be18 and Be14, respectively. Lines are to guide the eye.

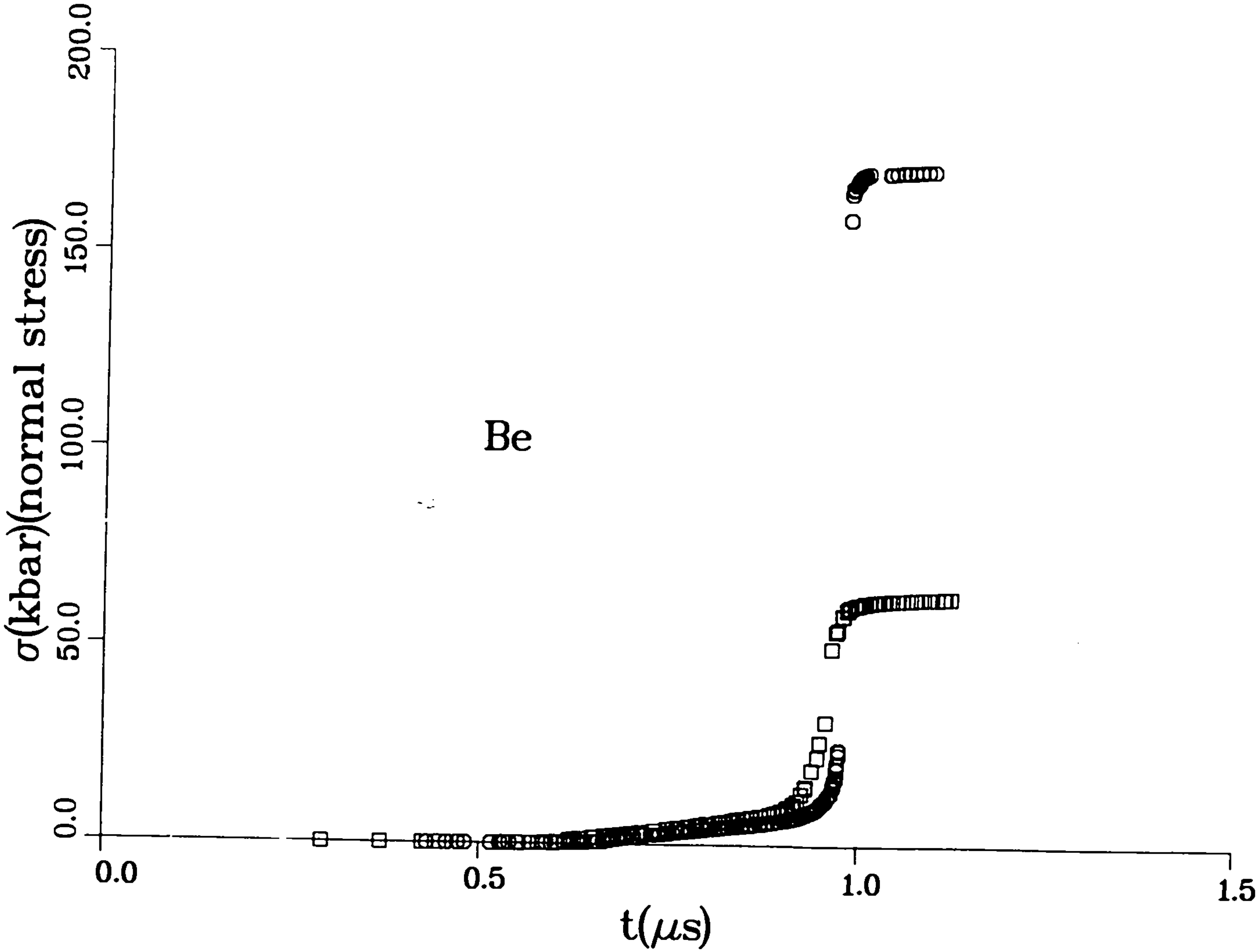

Fig. 11. *In situ* normal stress versus time for beryllium. Squares and circles are for shots Be18 and Be14, respectively.

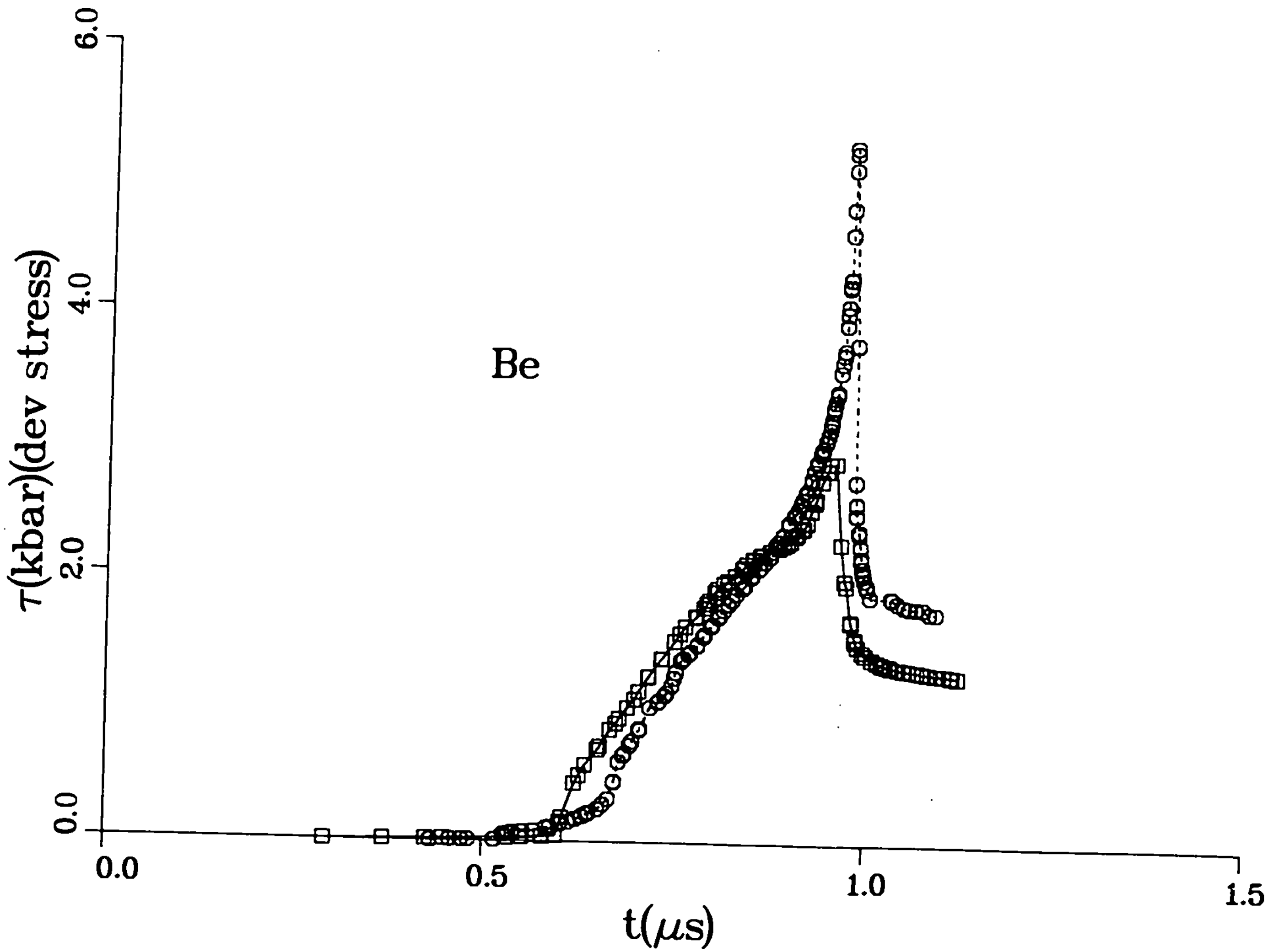

Fig. 12. *In situ* deviatoric stress versus time for beryllium. Squares and circles are for shots Be18 and Be14, respectively. Lines are to guide the eye.

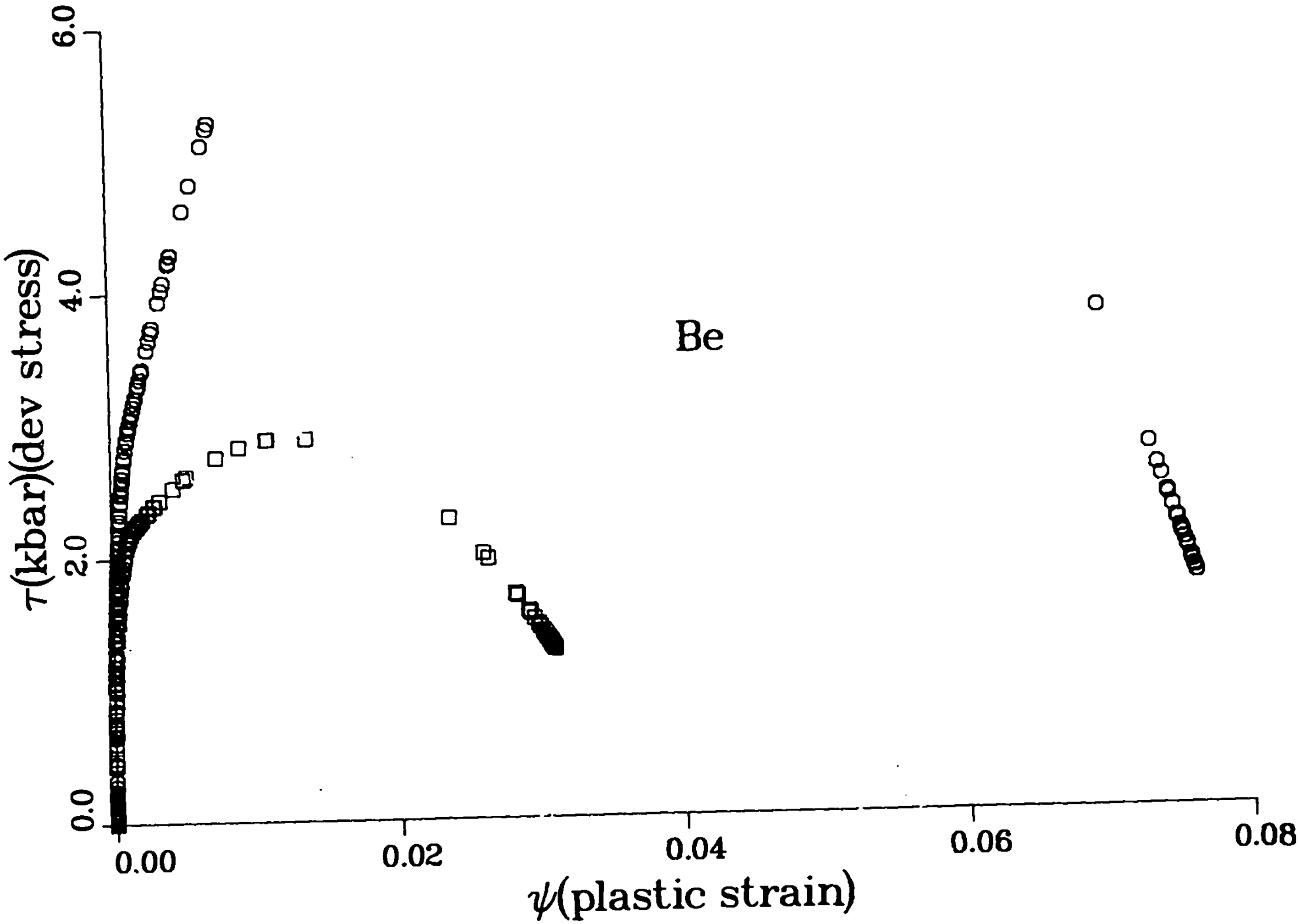

Fig. 13. *In situ* deviatoric stress versus plastic strain for beryllium. Squares and circles are for shots Be18 and Be14, respectively.

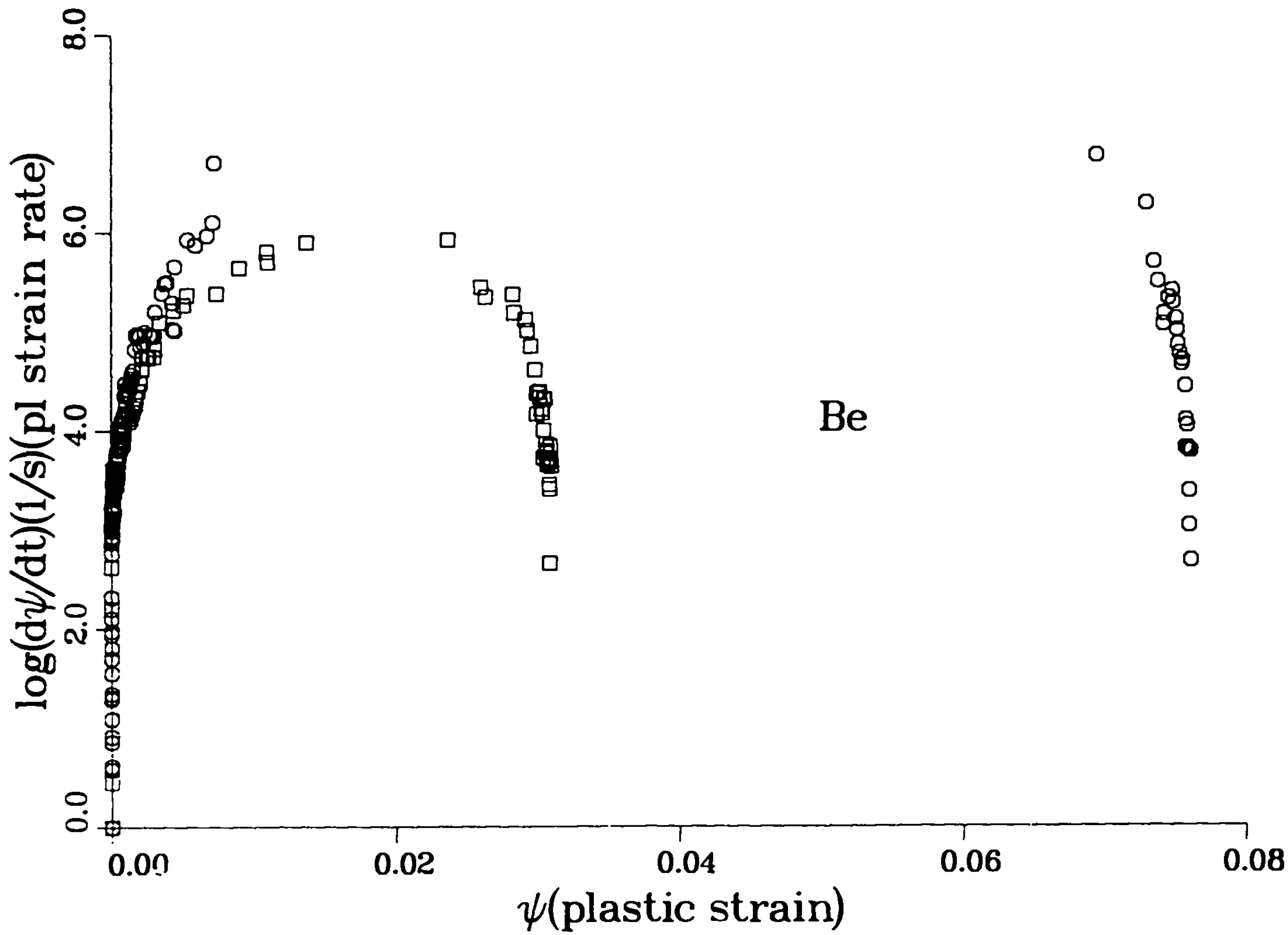

Fig. 14. Log(base 10) of *in situ* plastic strain rate versus plastic strain for beryllium. Squares and circles are for shots Be18 and Be14, respectively.

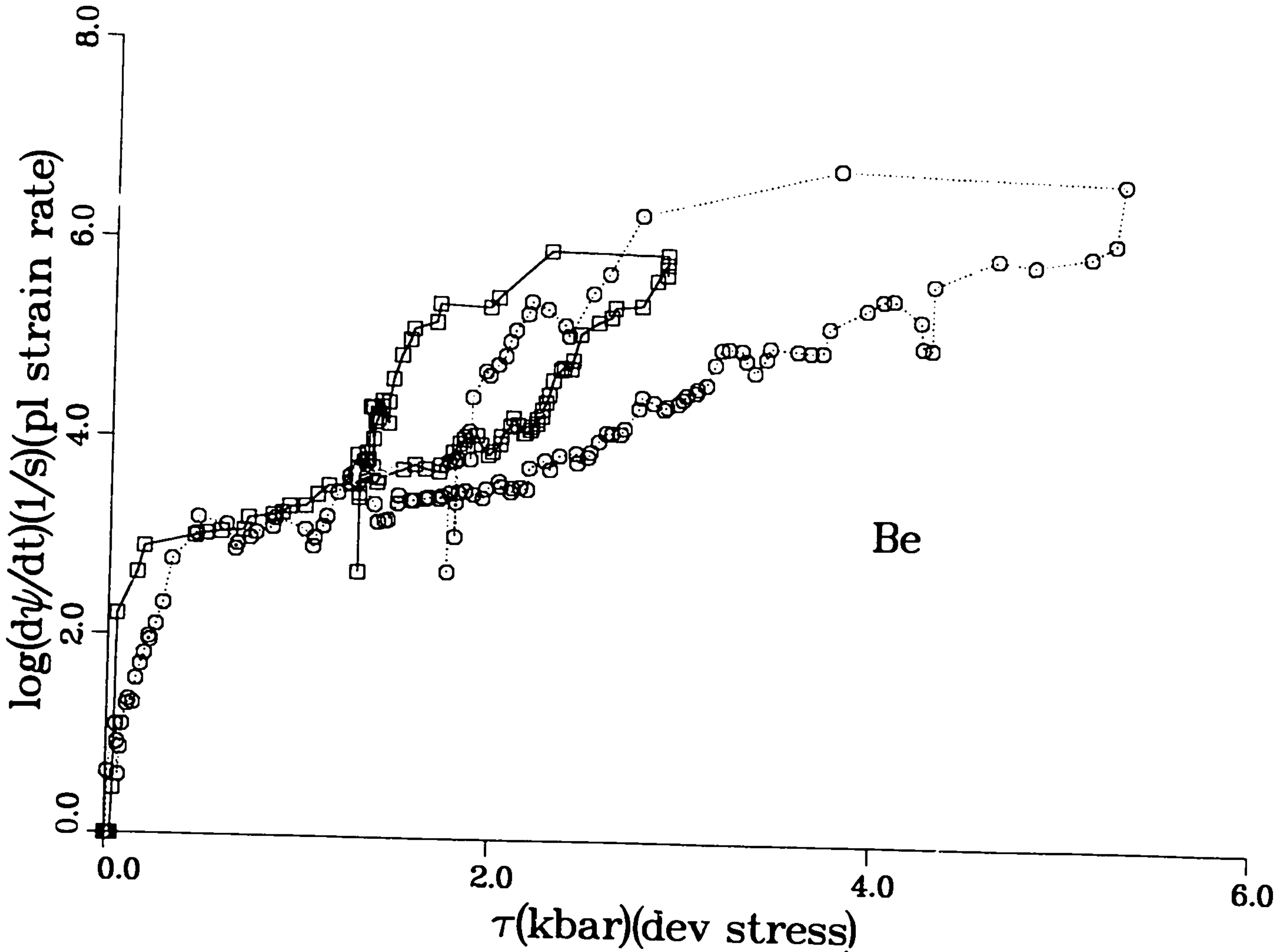

Fig. 15. Log(base 10) of *in situ* plastic strain rate versus deviatoric stress for beryllium. Squares and circles are for shots Be18 and Be14, respectively.

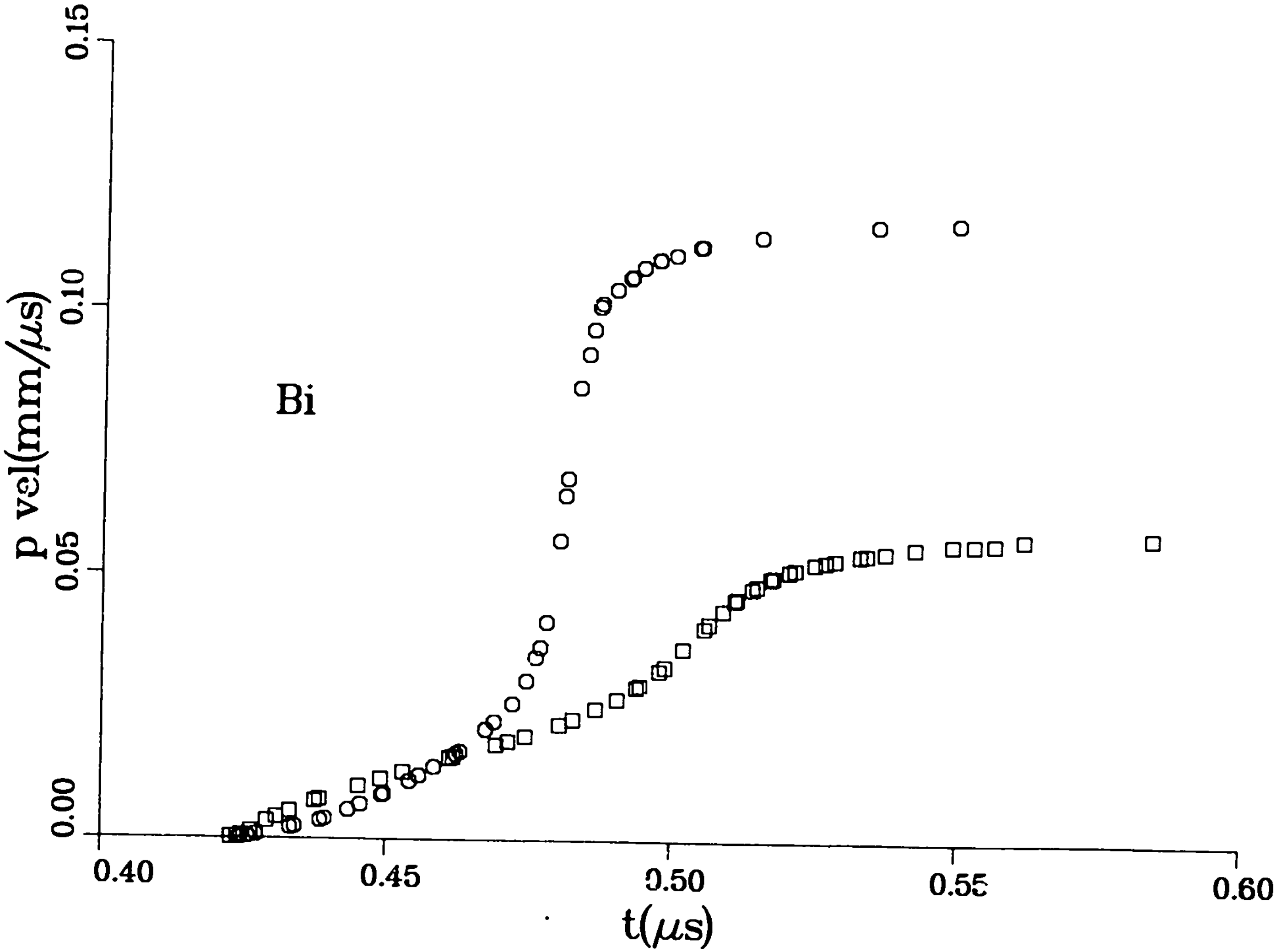

Fig. 16. *In situ* particle velocity versus time for bismuth. Squares and circles are for shots 147 and 149, respectively.

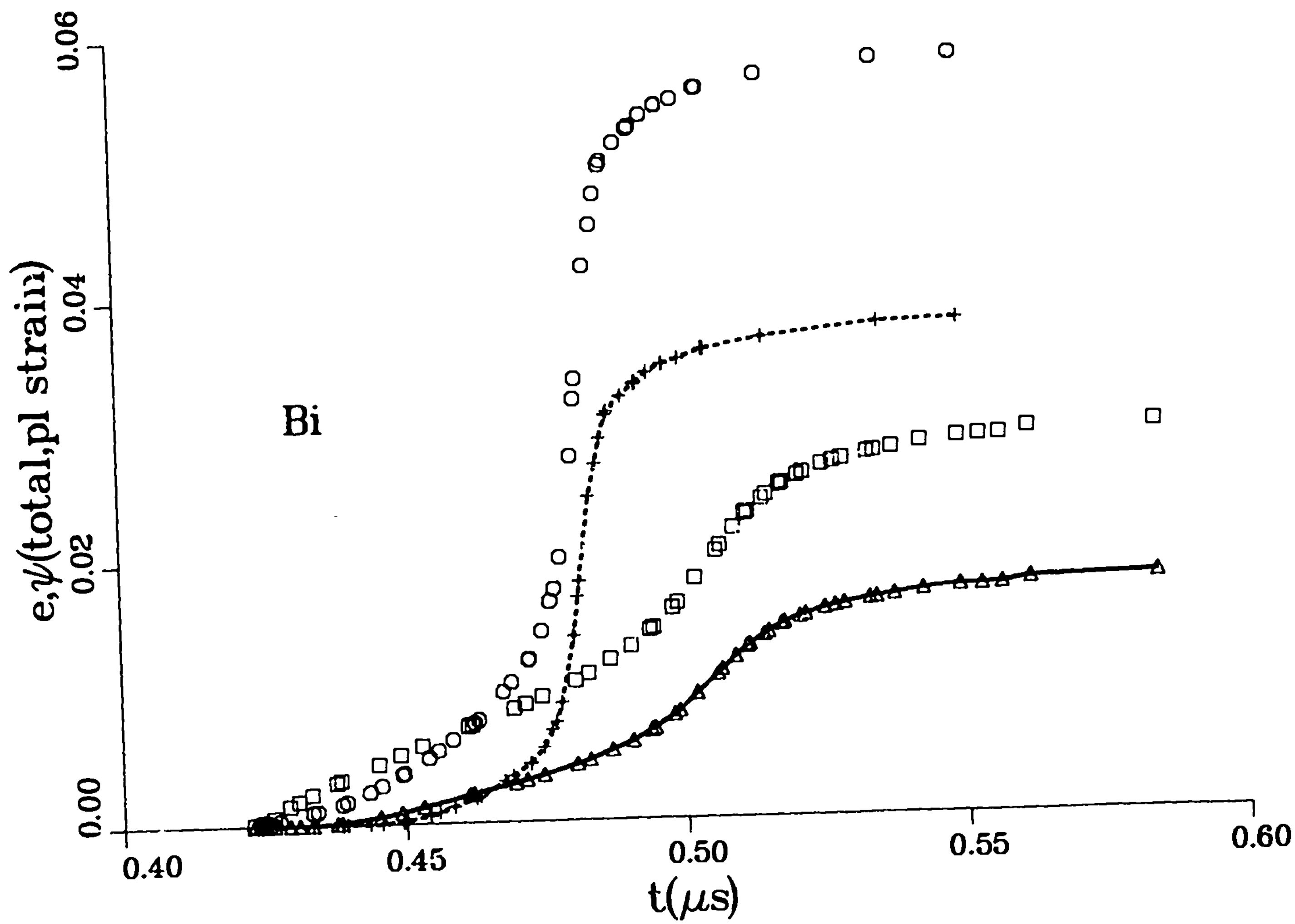

Fig. 17. *In situ* total and plastic strains versus time for bismuth. Squares and circles are total stains for shots 147 and 149, respectively. Triangles and pluses are plastic strains for shots 147 and 149, respectively. Lines are to guide the eye.

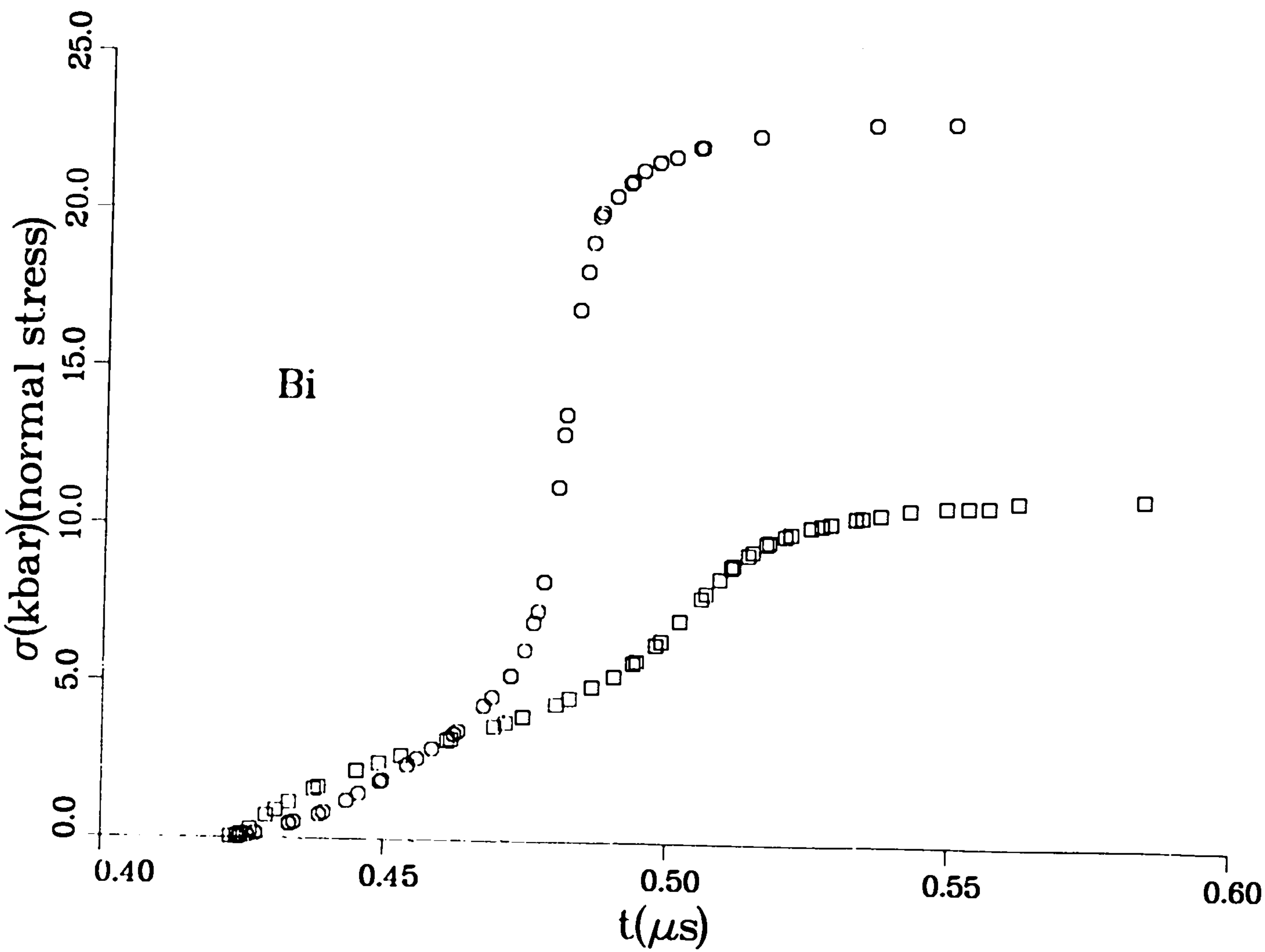

Fig. 18. *In situ* normal stress versus time for bismuth. Squares and circles are for shots 147 and 149, respecitvely.

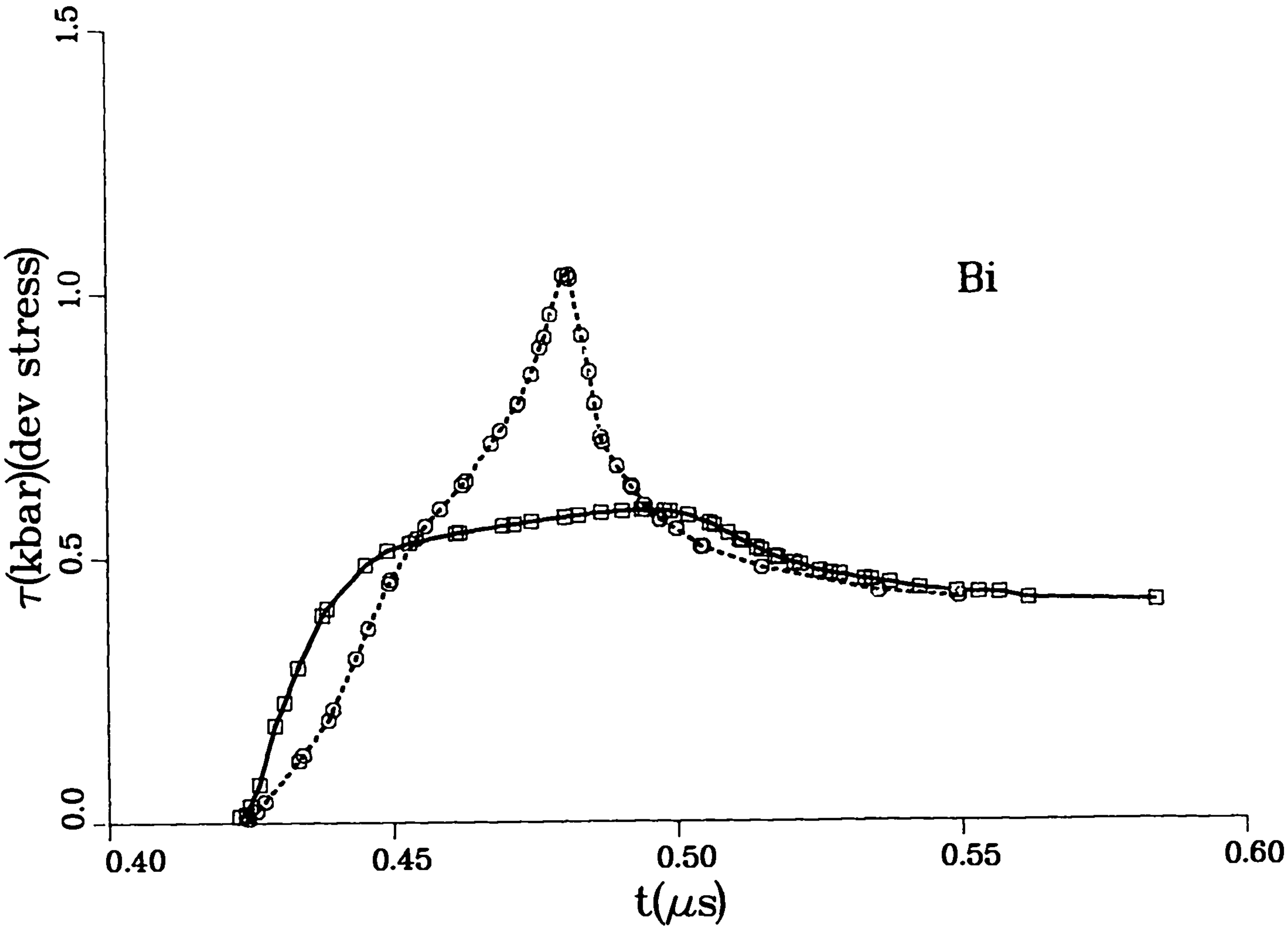

Fig. 19. *In situ* deviatoric stress versus time for bismuth. Squares and circles are for shots 147 and 149, respectively. Lines are to guide the eye.

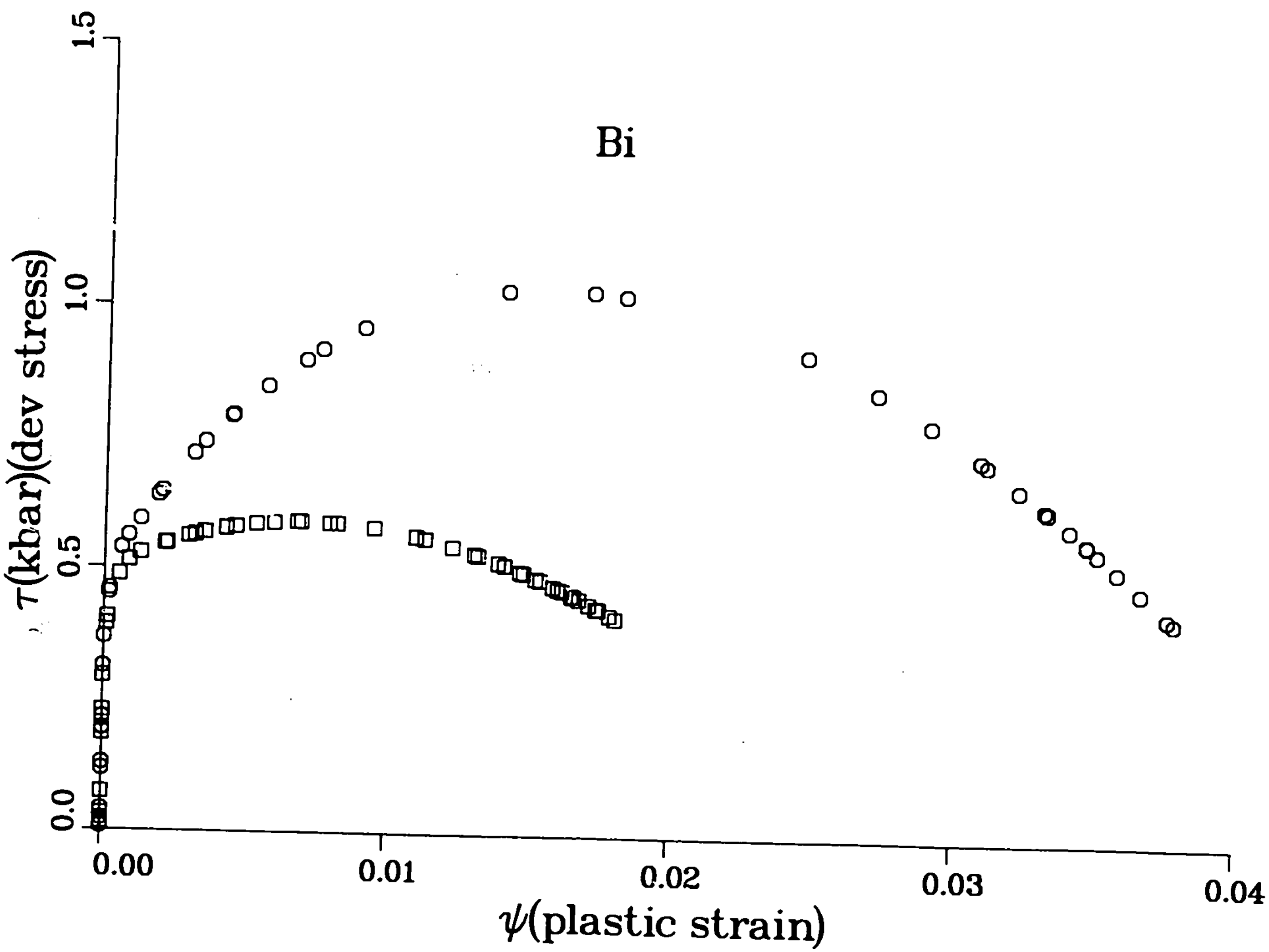

Fig. 20. *In situ* deviatoric stress versus plastic strain for bismuth. Squares and circles are for shots 147 and 149, respectively.

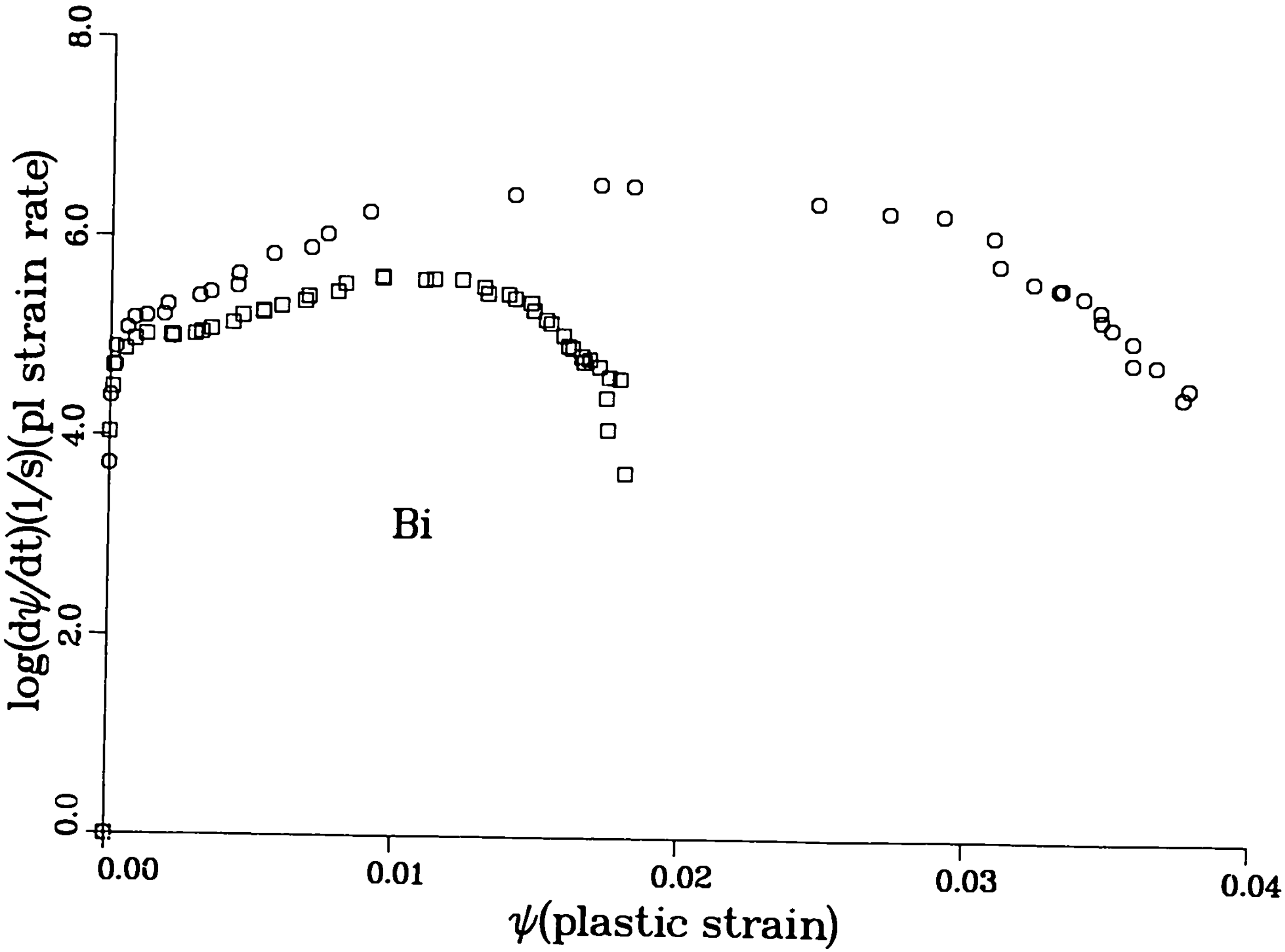

Fig. 21. Log(base 10) of *in situ* plastic strain rate versus plastic strain for bismuth. Squares and circles are for shots 147 and 149, respectively.

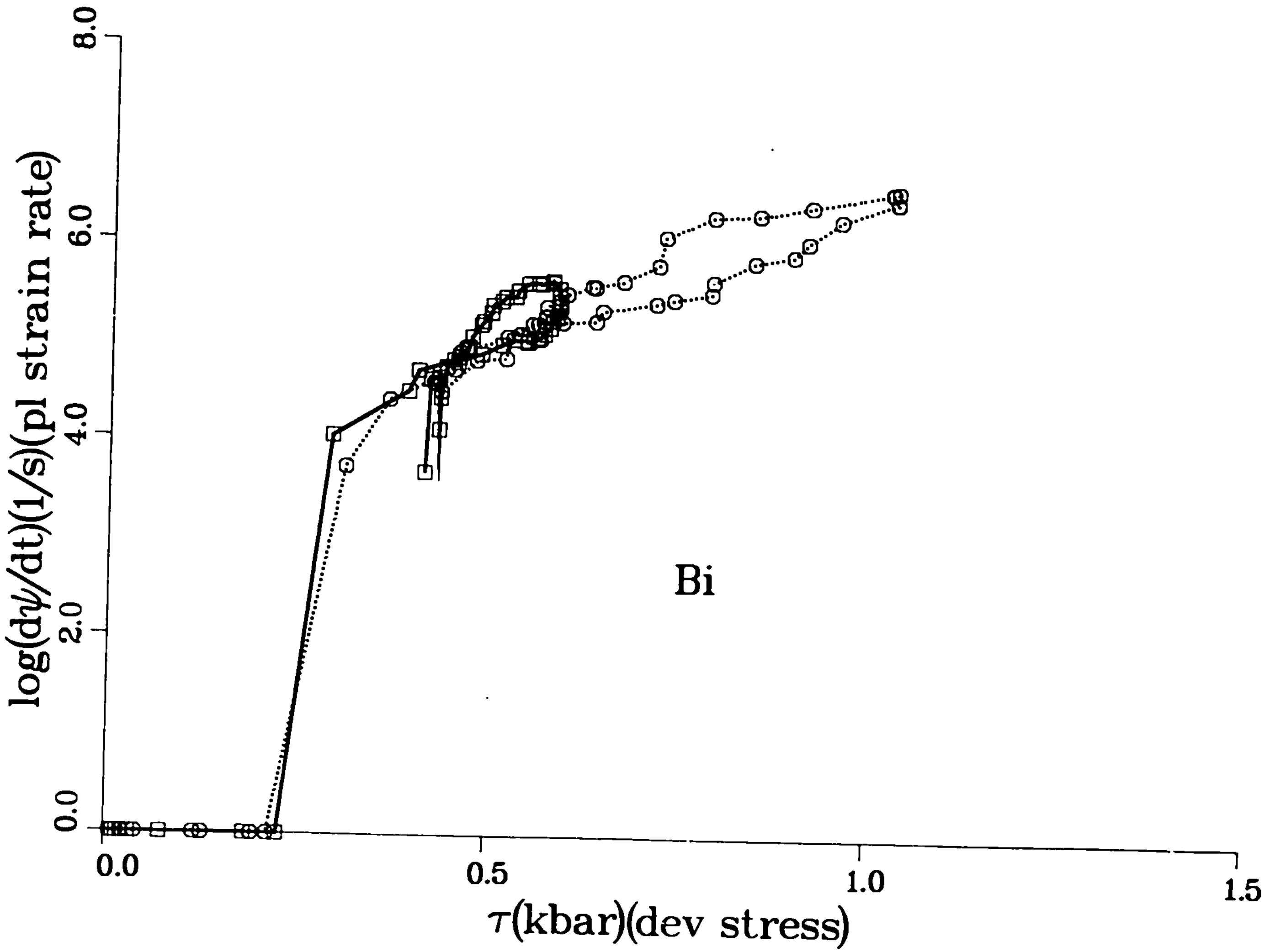

Fig. 22. Log(base 10) of *in situ* plastic strain rate versus deviatoric stress for bismuth. Squares and circles are for shots 147 and 149, respectively. Lines are to guide the eye.

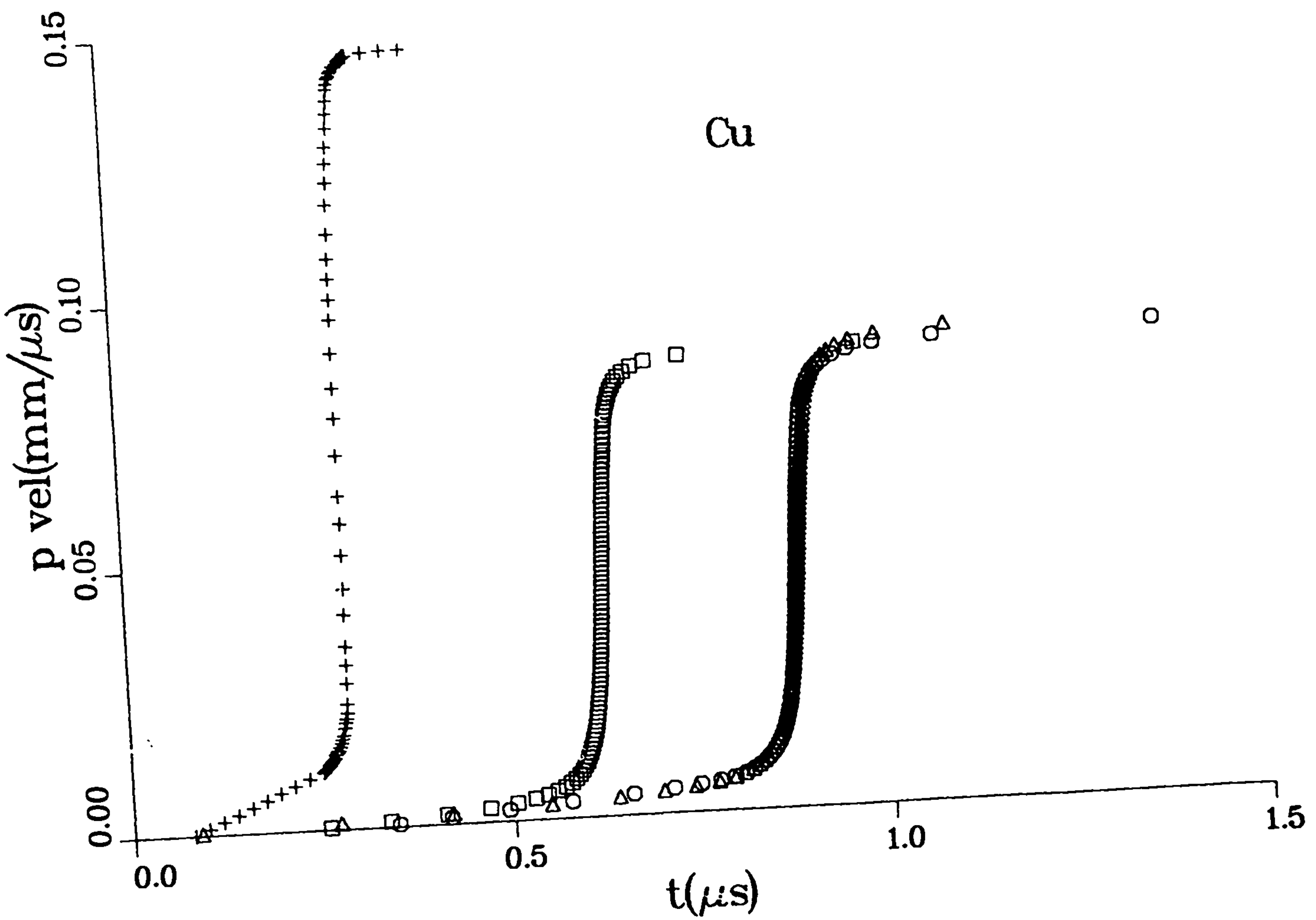

Fig. 23. *In situ* particle velocity versus time for copper. Squares, circles, triangles, and pluses are for shots H800, H801, H802, and 54 kbar, respectively.

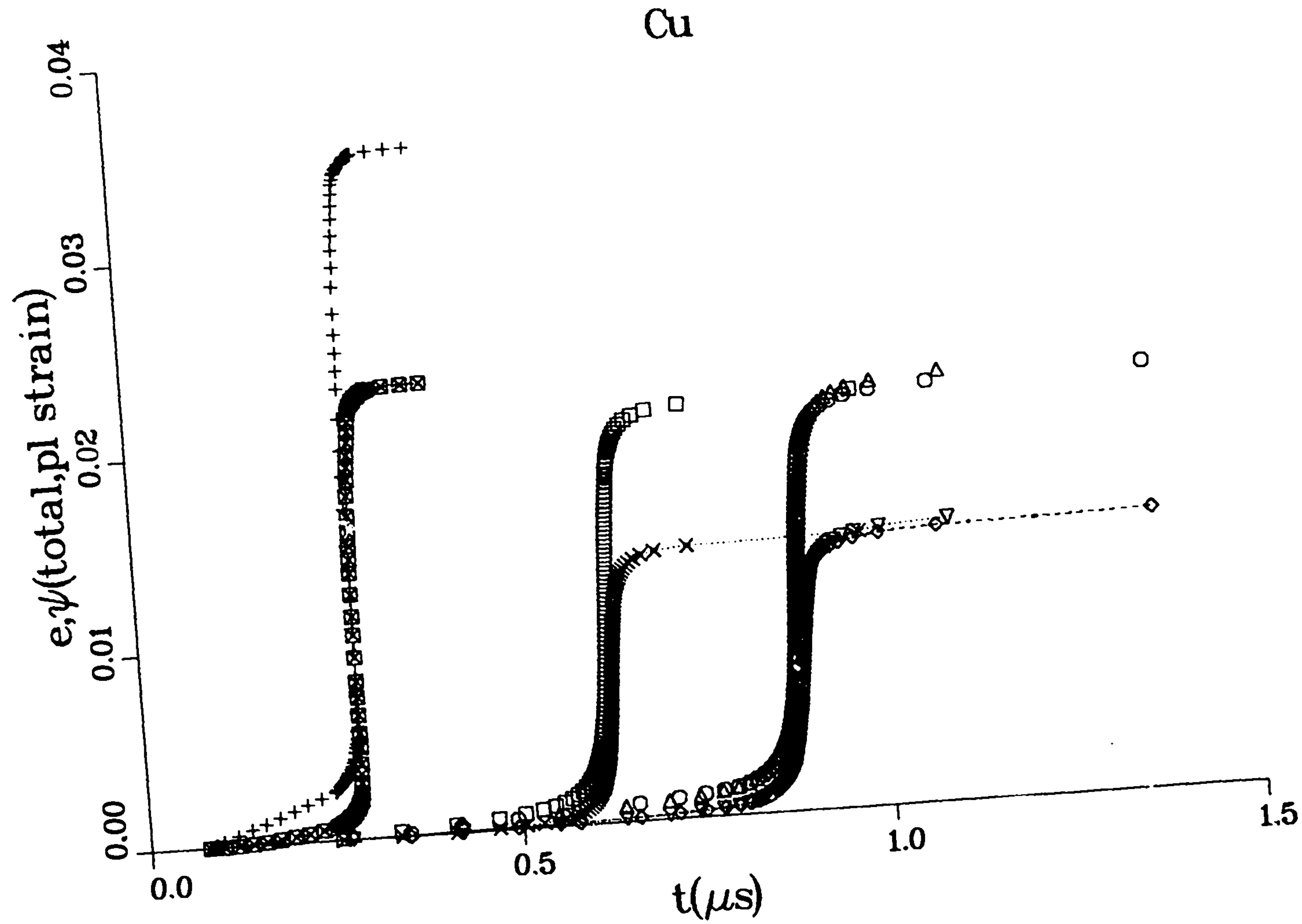

Fig. 24. *In situ* total and plastic strains versus time for copper. Squares, circles, triangles, and pluses are total strains for shots H800. H801, H802, and 54 kbar. respectively. Xs. diamonds, inverted triangles, and square-croses are plastic strains for shots H800, H801, H802, and 54 kbar. repsectively. Lines are to guide the eye.

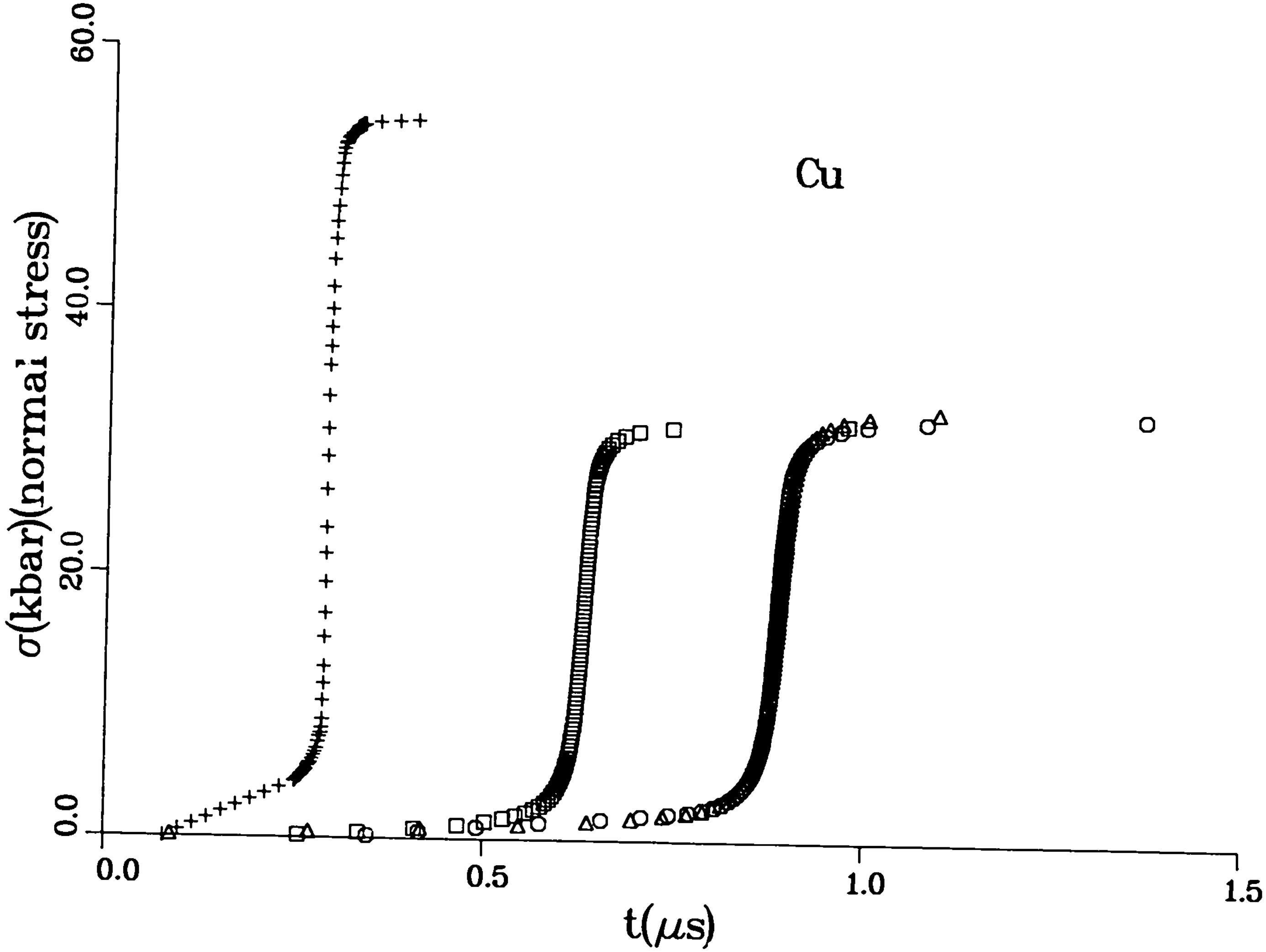

Fig. 25. *In situ* normal stress versus time for copper. Squares, circles, triangles, and pluses are for shots H800, H801, H802, and 54 kbar, respectively.

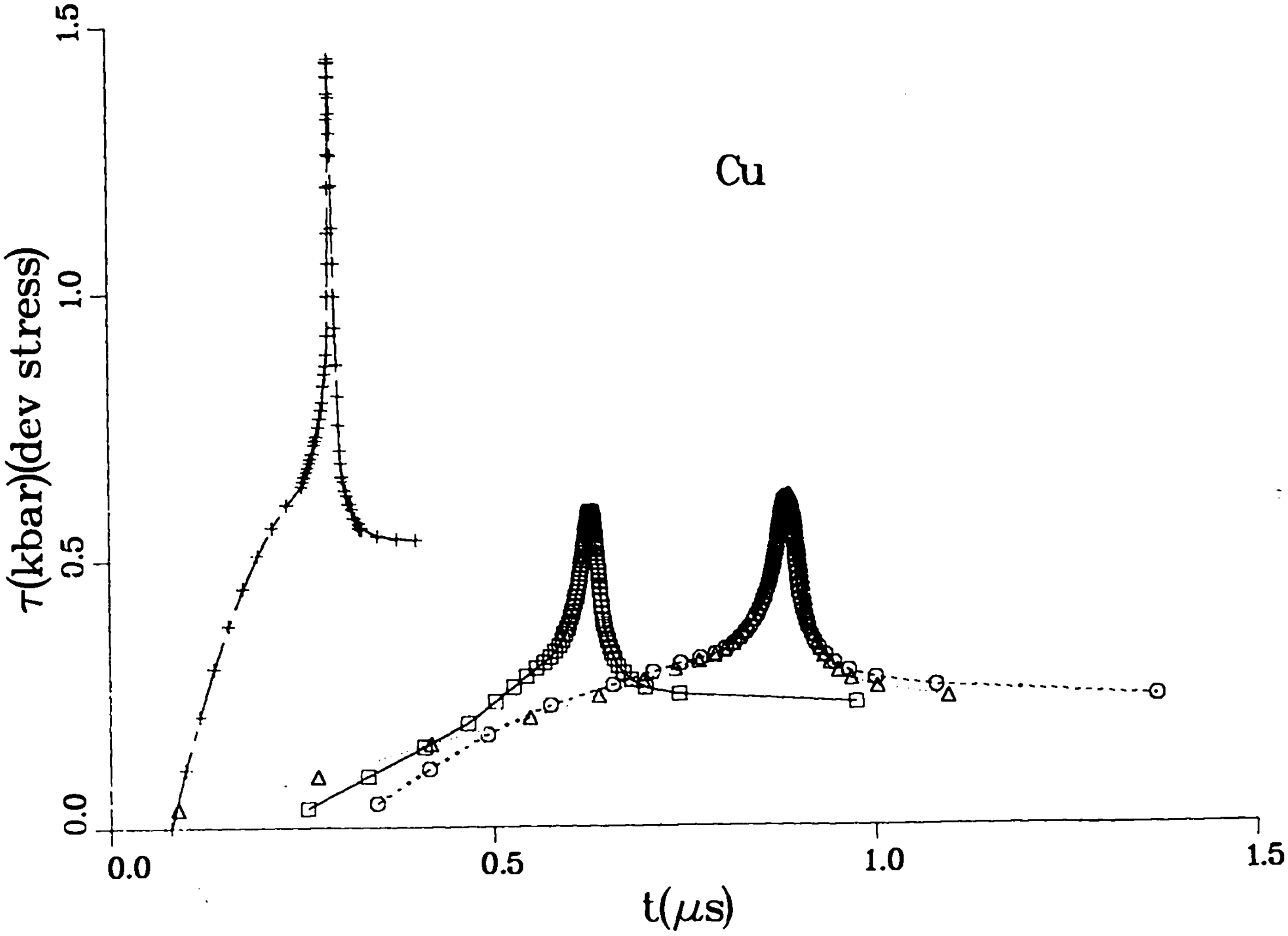

Fig. 26. *In situ* deviatoric stress versus time for copper. Correspondence between symbols and shots same as in Fig. 25. Lines are to guide the eye.

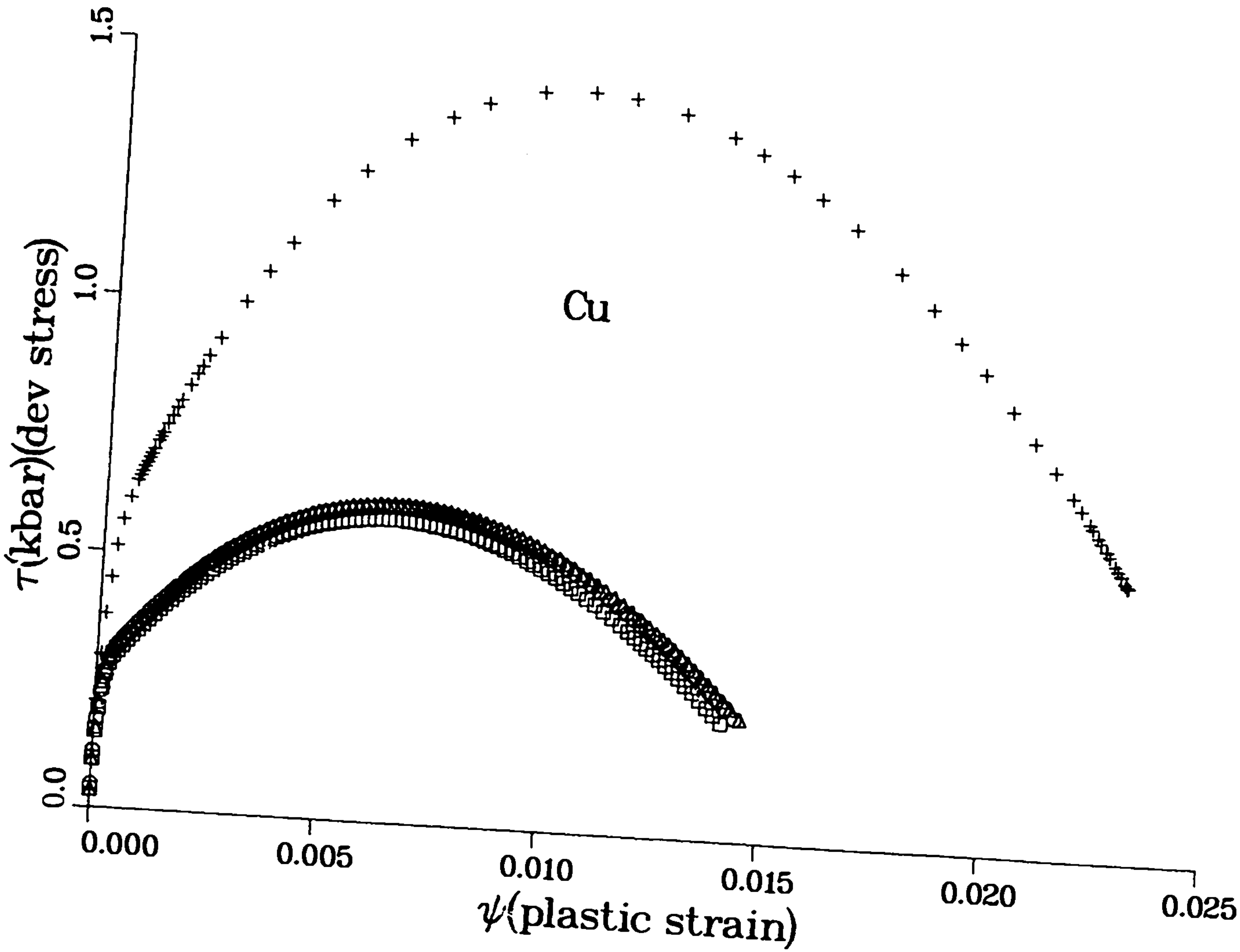

Fig. 27. *In situ* deviatoric stress versus plastic strain for copper. Correspondence between symbols and shots same as in Fig. 25.

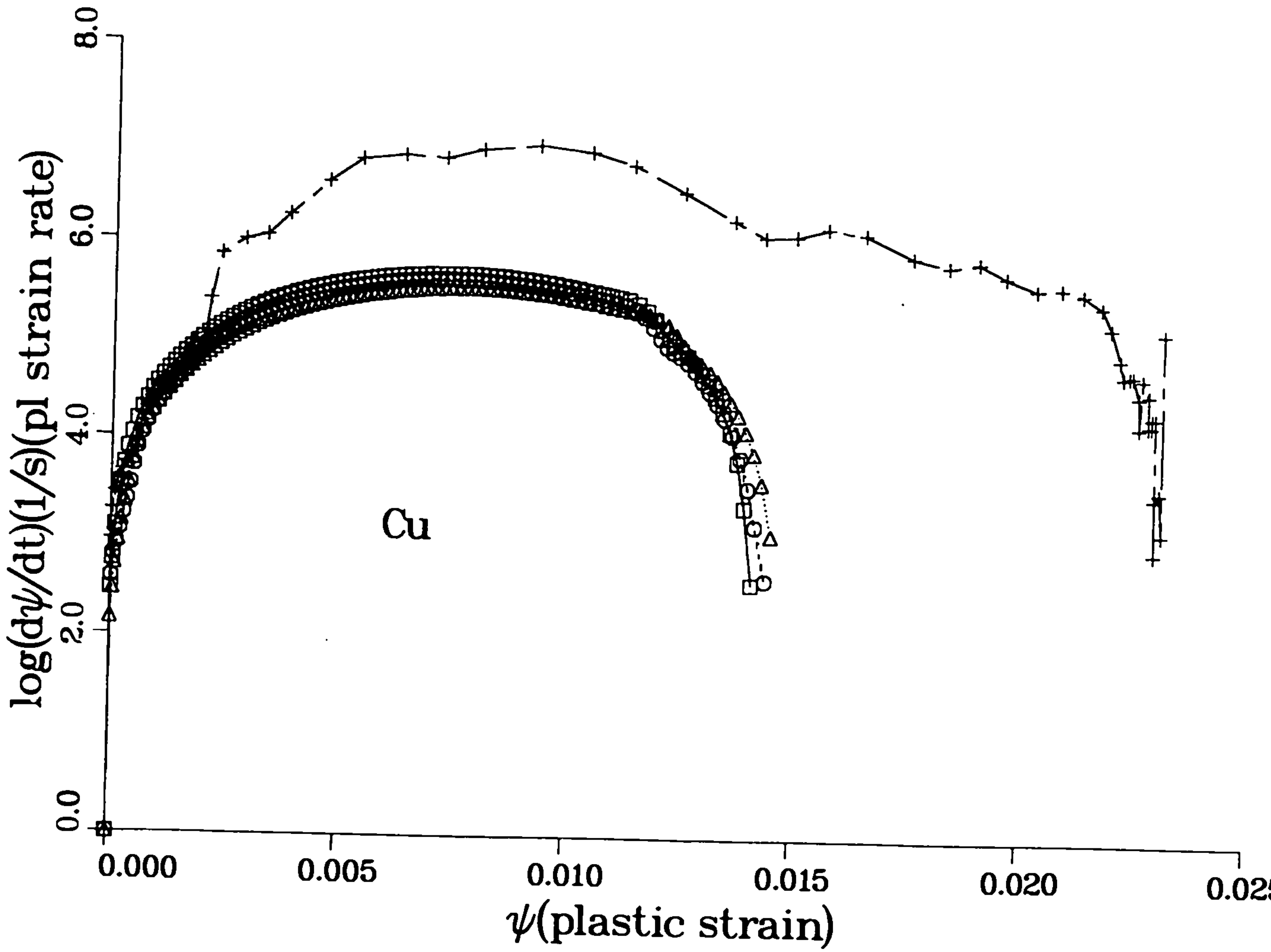

Fig. 28. Log(base 10) of *in situ* plastic strain rate versus plastic strain for copper. Correspondence between symbols and shots same as in Fig. 25. Lines are to guide the eye.

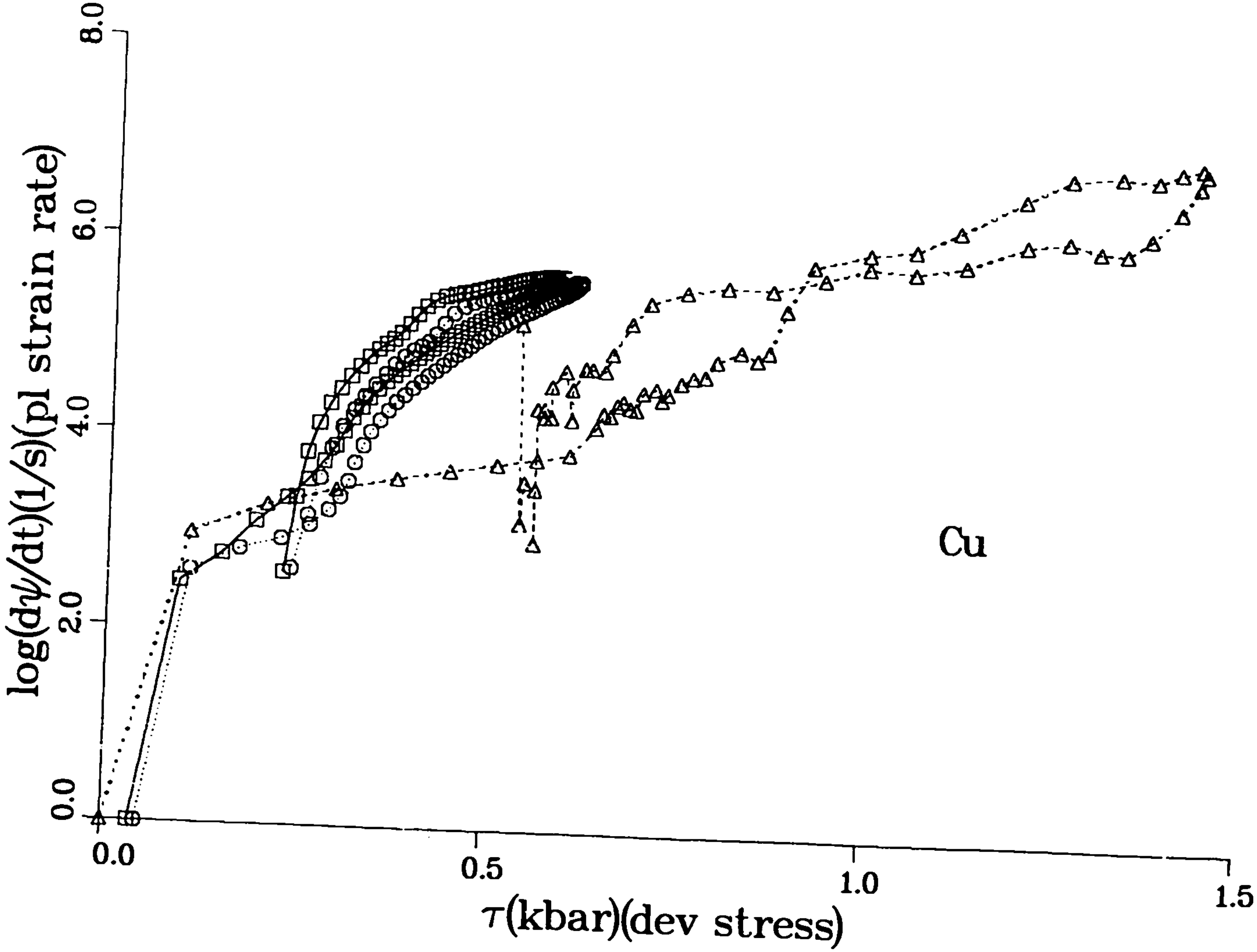

Fig. 29. Log(base 10) of *in situ* plastic strain rate versus deviatoric stress for copper. Squares, circles, and triangles are for shots H800, H801, and 54 kbar, respectively. Lines are to guide the eye.

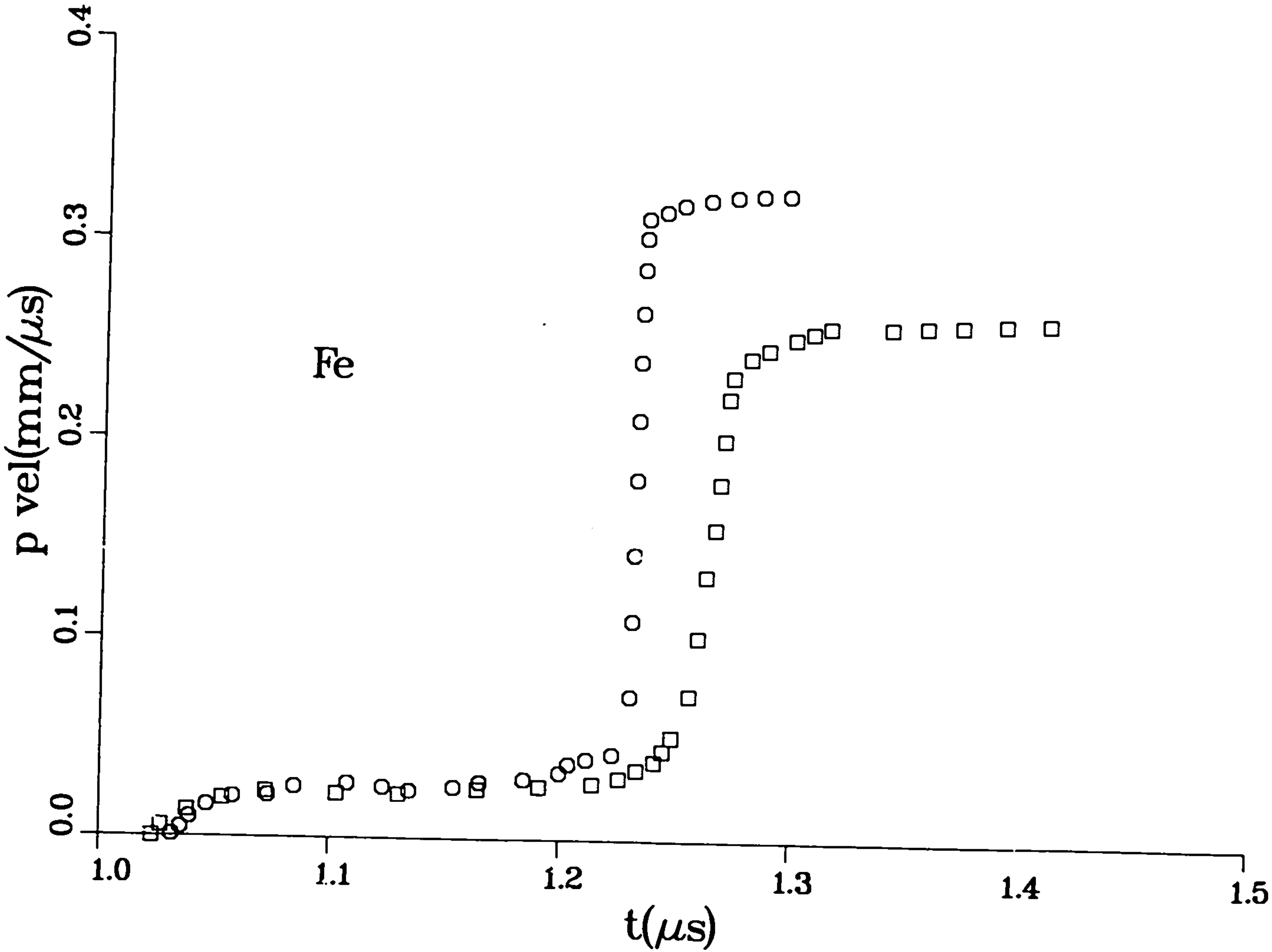

Fig. 30. *In situ* particle velocity versus time for iron. Squares and circles are for shots 15 and 16, respectively.

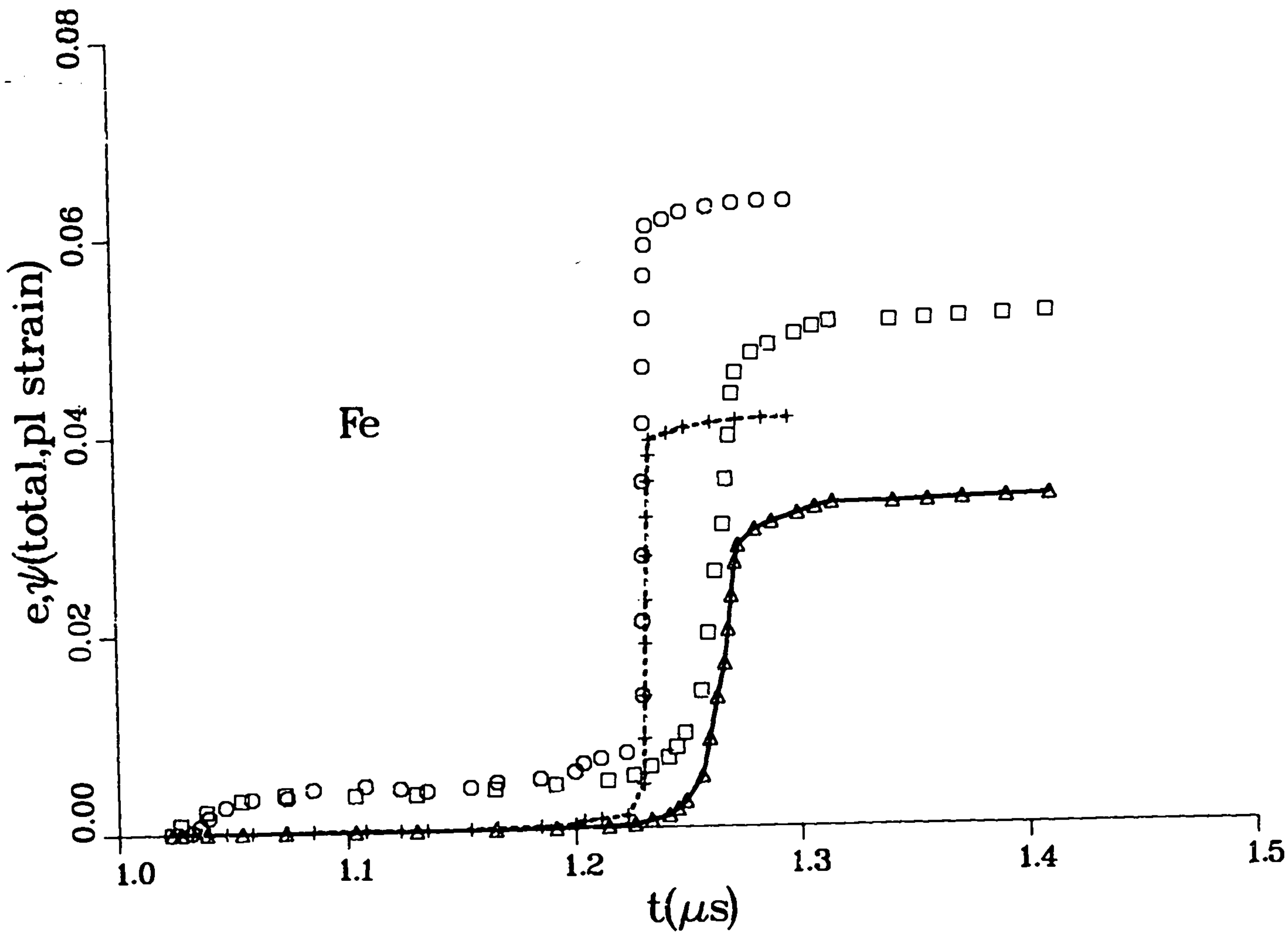

Fig. 31. *In situ* total and plastic strains for iron. Squares and circles are total strains for shots 15 and 16, repsectively. Triangles and pluses are plastic strains for shots 15 and 16, respectively. Lines are to guide the eye.

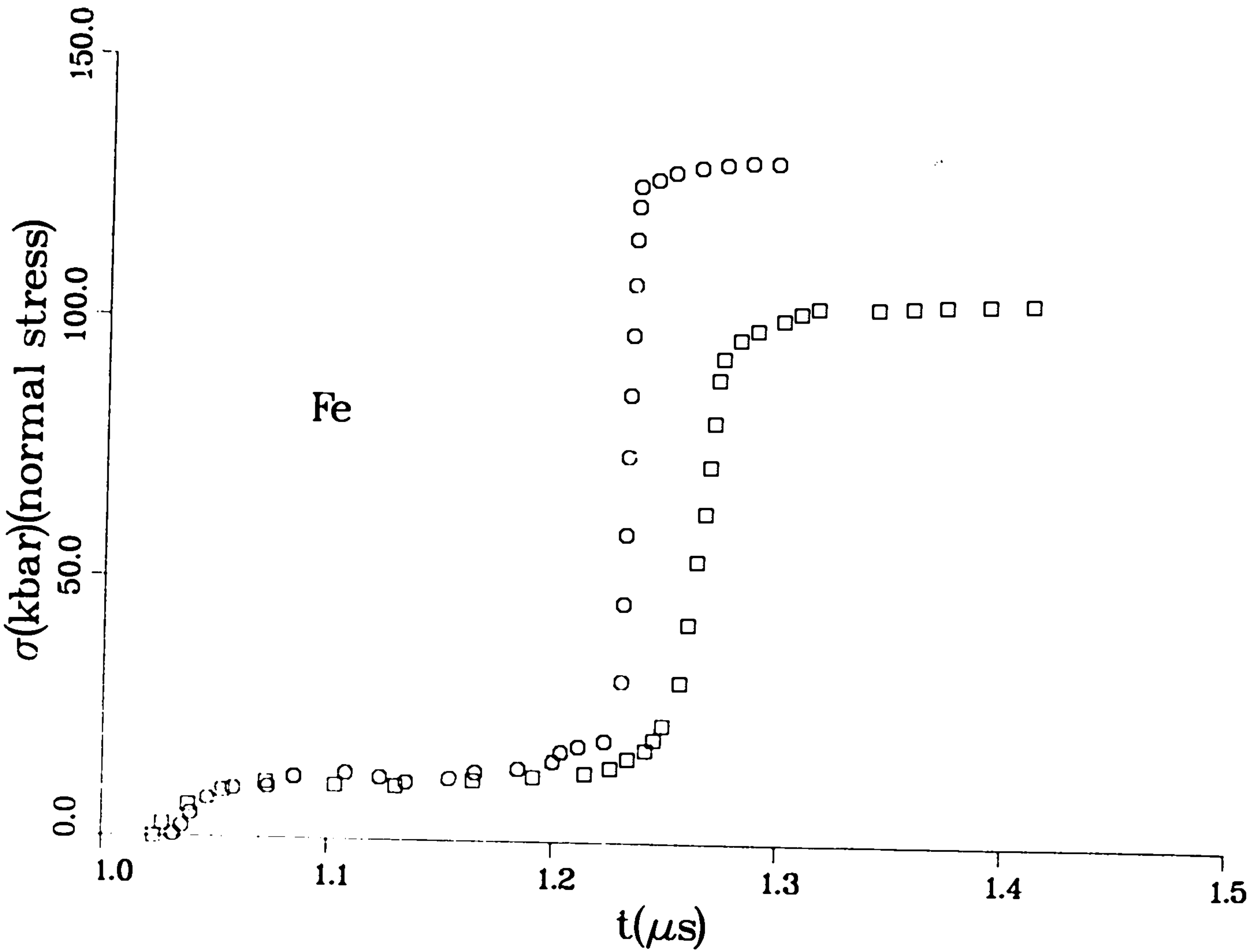

Fig. 32. *In situ* normal stress versus time for iron. Squares and circles are for shots 15 and 16, respectively.

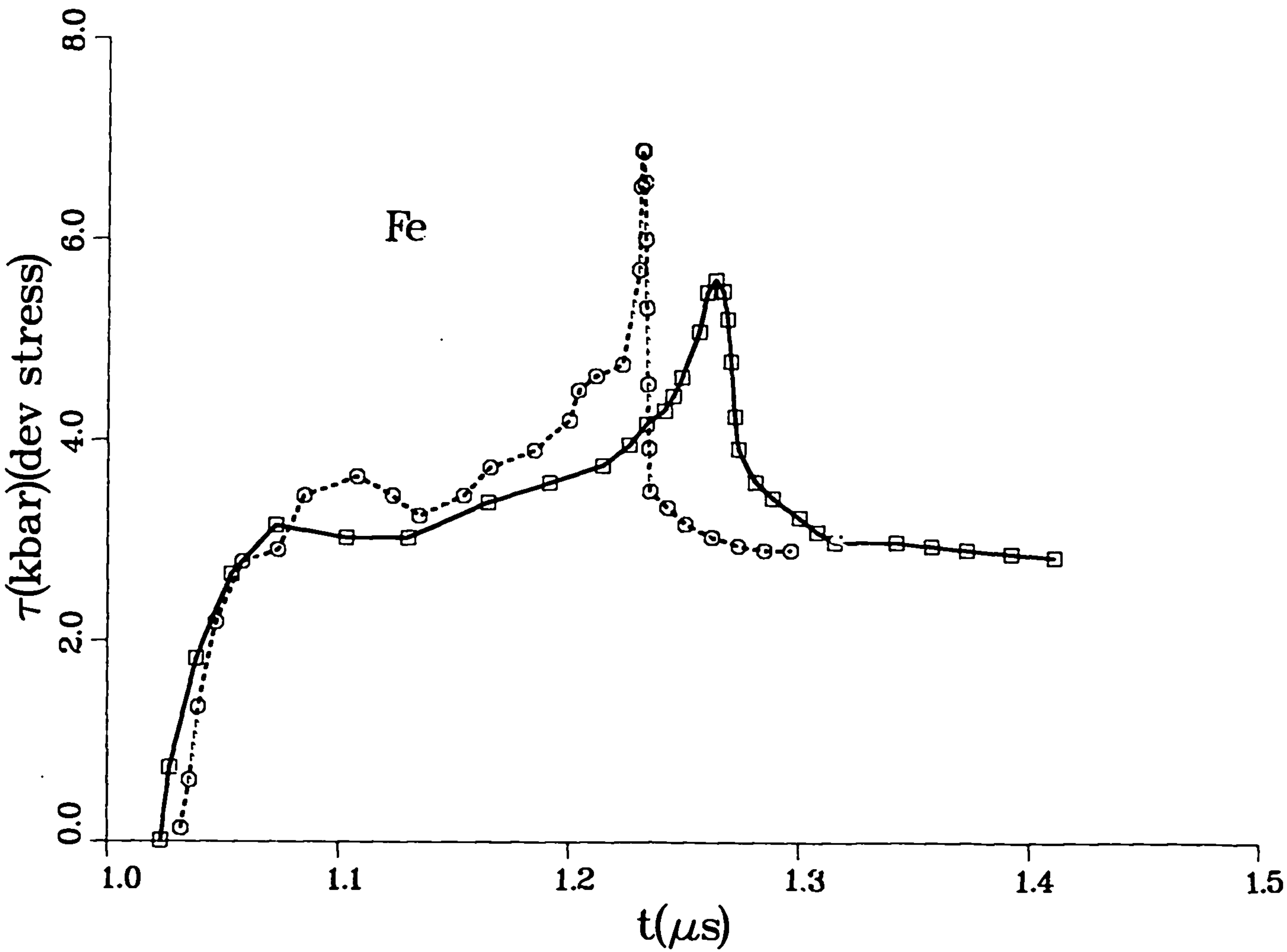

Fig. 33. *In situ* deviatoric stress versus time for iron. Squares and circles are for shots 15 and 16, respectively. Lines are to guide the eye.

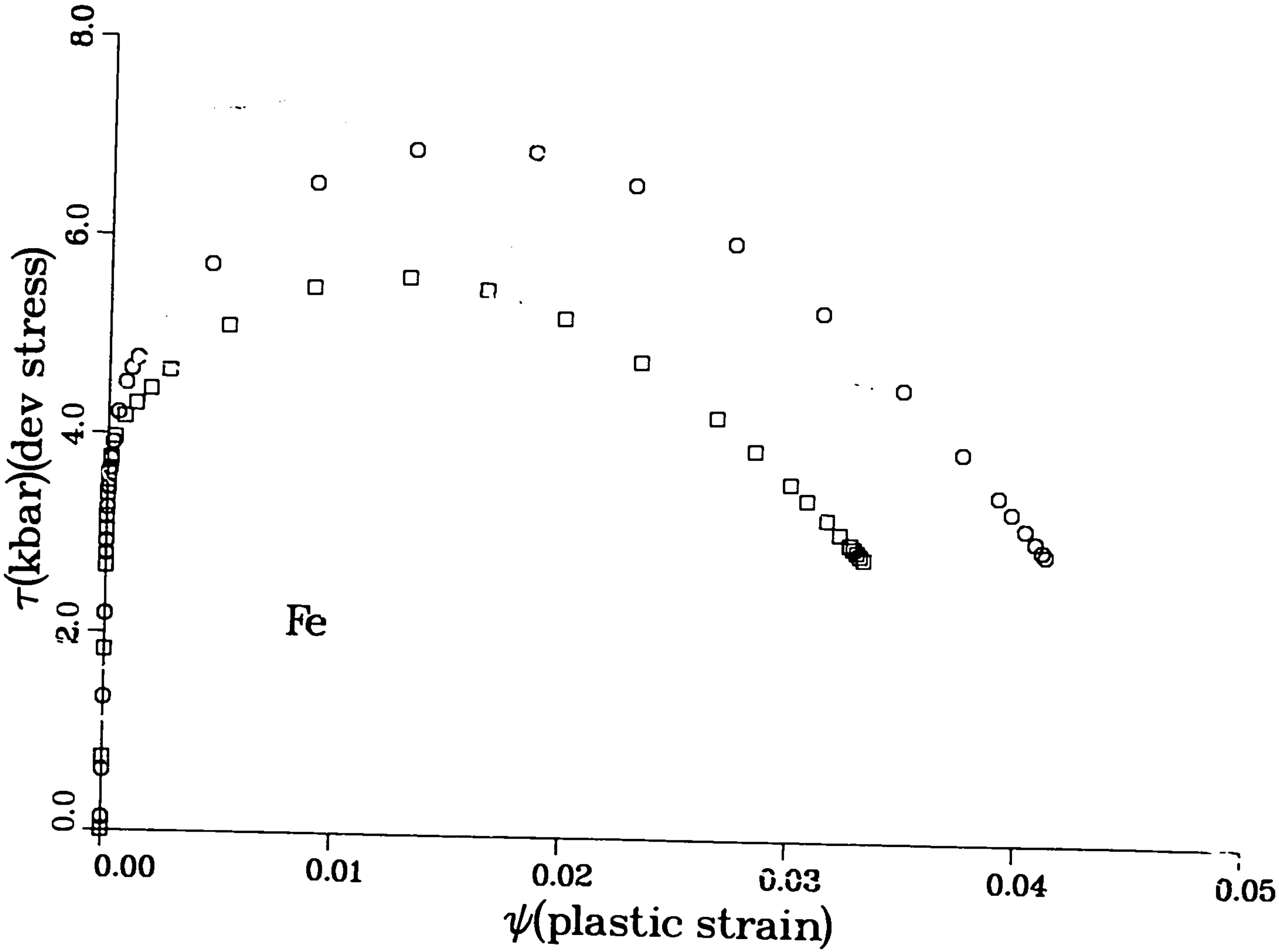

Fig. 34. *In situ* deviatoric stress versus plastic strain for iron. Squares and circles are for shots 15 and 16, respectively.

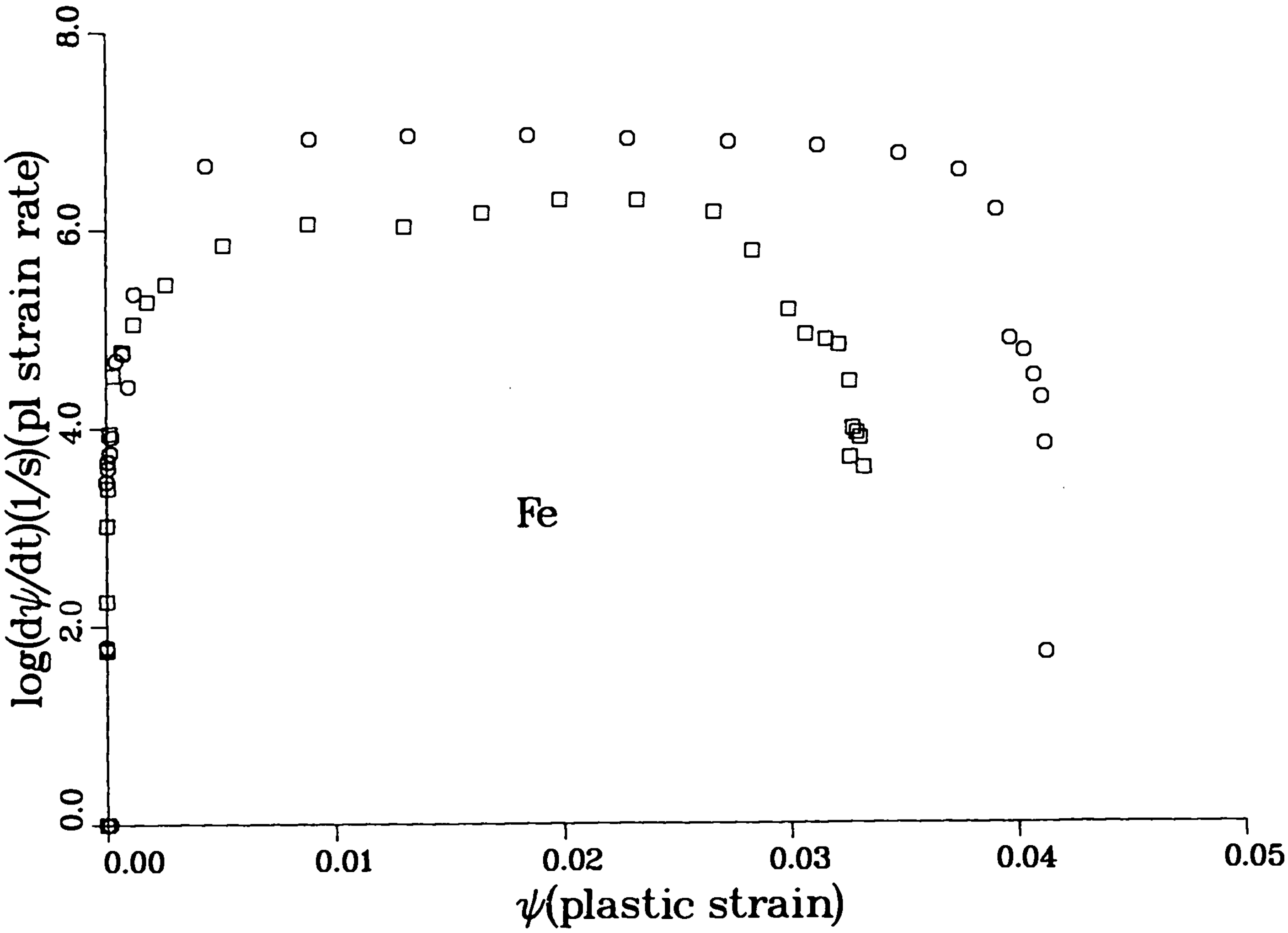

Fig. 35. Log(base 10) of *in situ* plastic strain rate versus plastic strain for iron. Squares and circles are for shots 15 and 16, respectively.

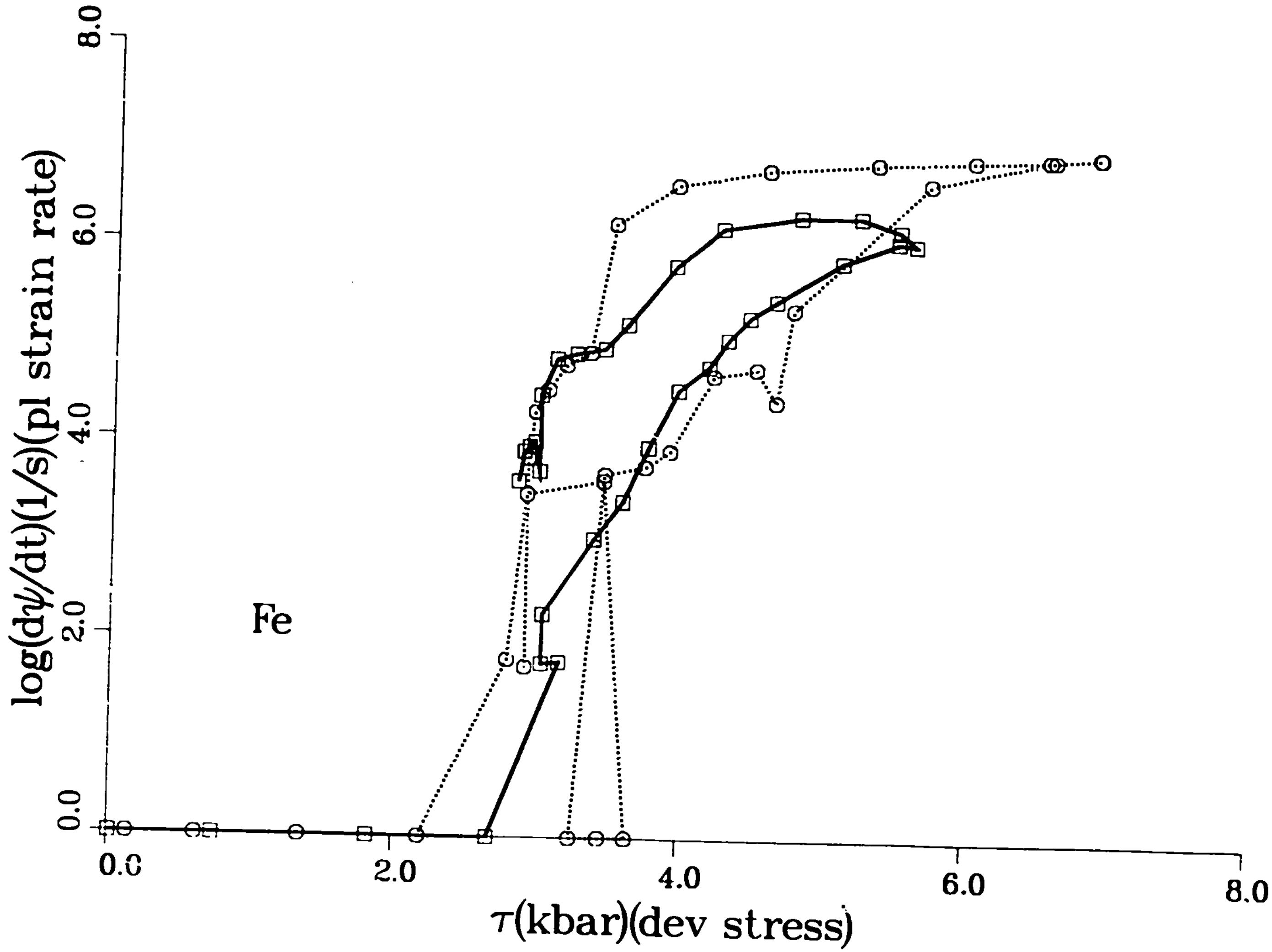

Fig. 36. Log(base 10) of *in situ* plastic strain rate versus deviatoric stress for iron. Squares and circles are for shots 15 and 16, repsectively. Lines are to guide the eye.

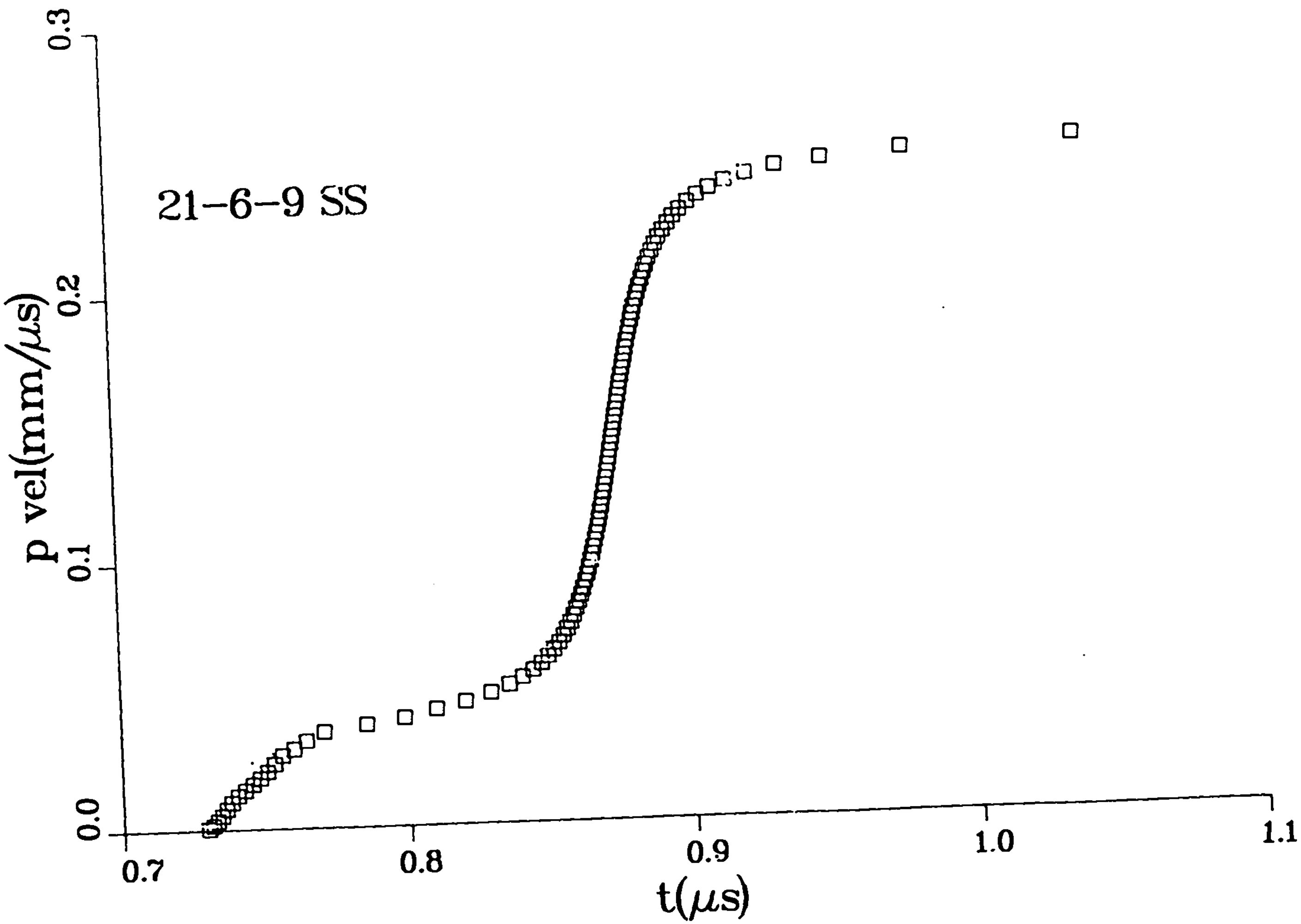

Fig. 37. *In situ* particle velocity versus time for shot SSWP1S of 21-6-9 stainless steel.

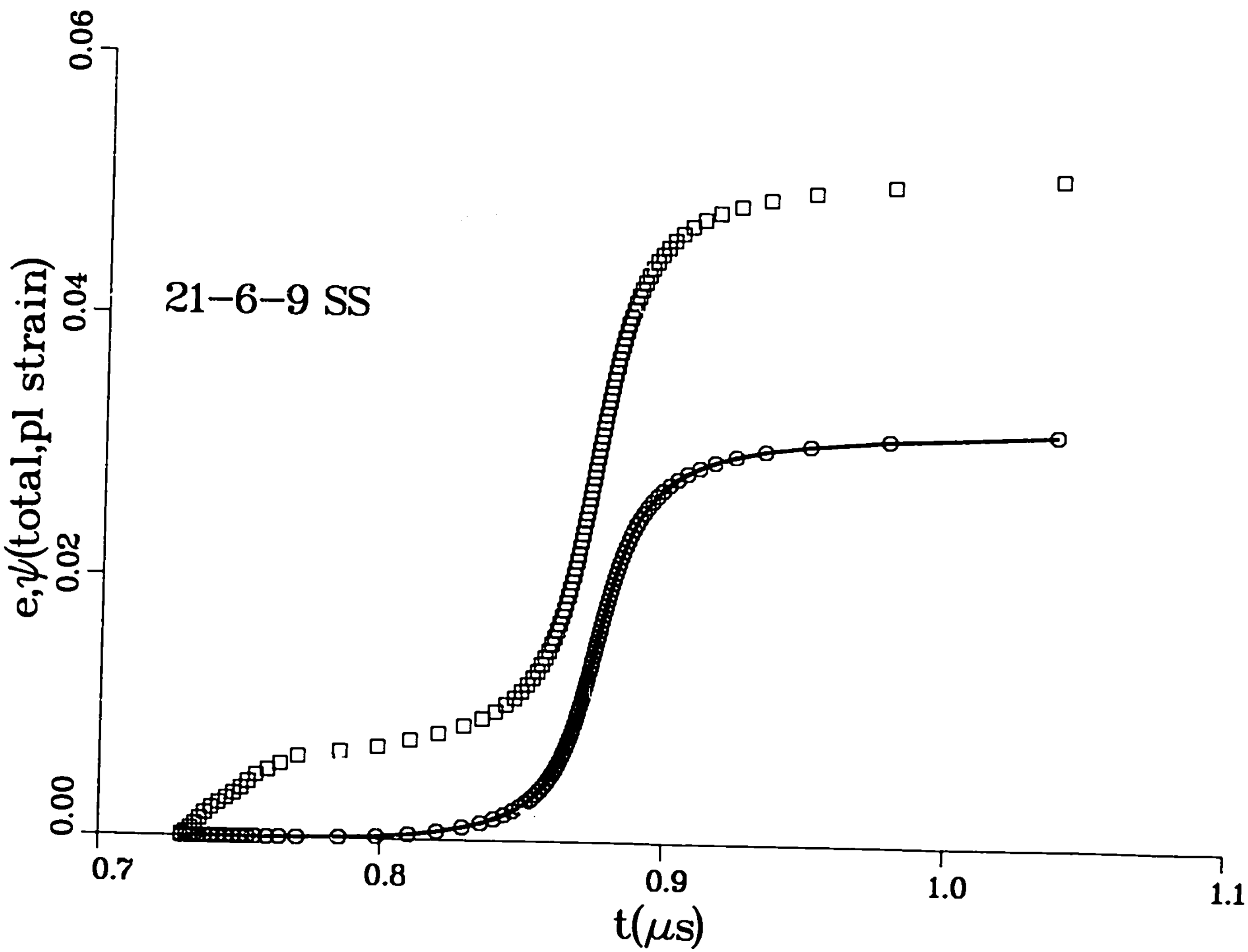

Fig. 38. *In situ* total(squares) and plastic(circles) strain versus time for shot SSW1PS of 21-6-9 stainless steel. Line is to guide the eye.

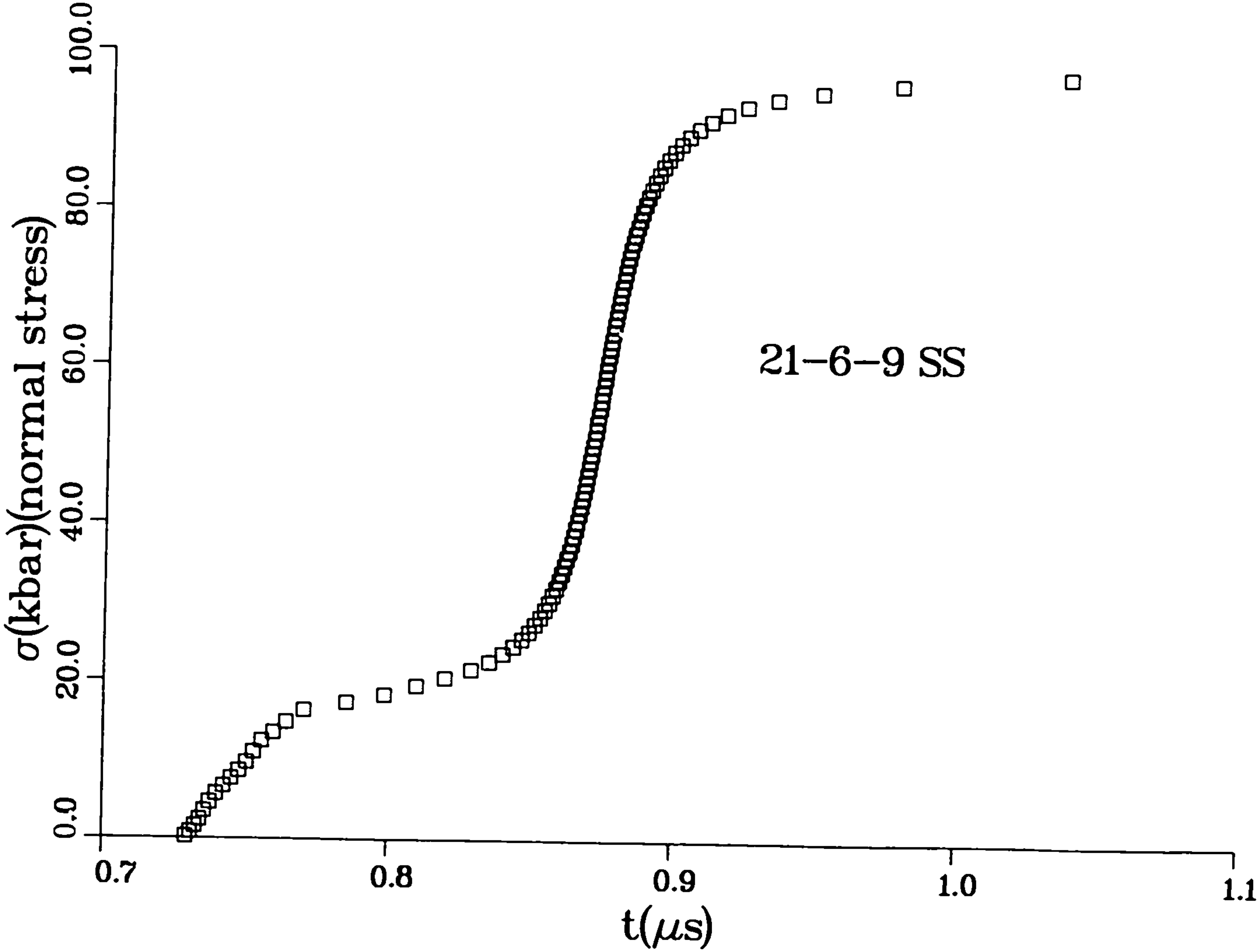

Fig. 39. *In situ* normal stress versus time for shot SSWP1S of 21-6-9 stainless steel.

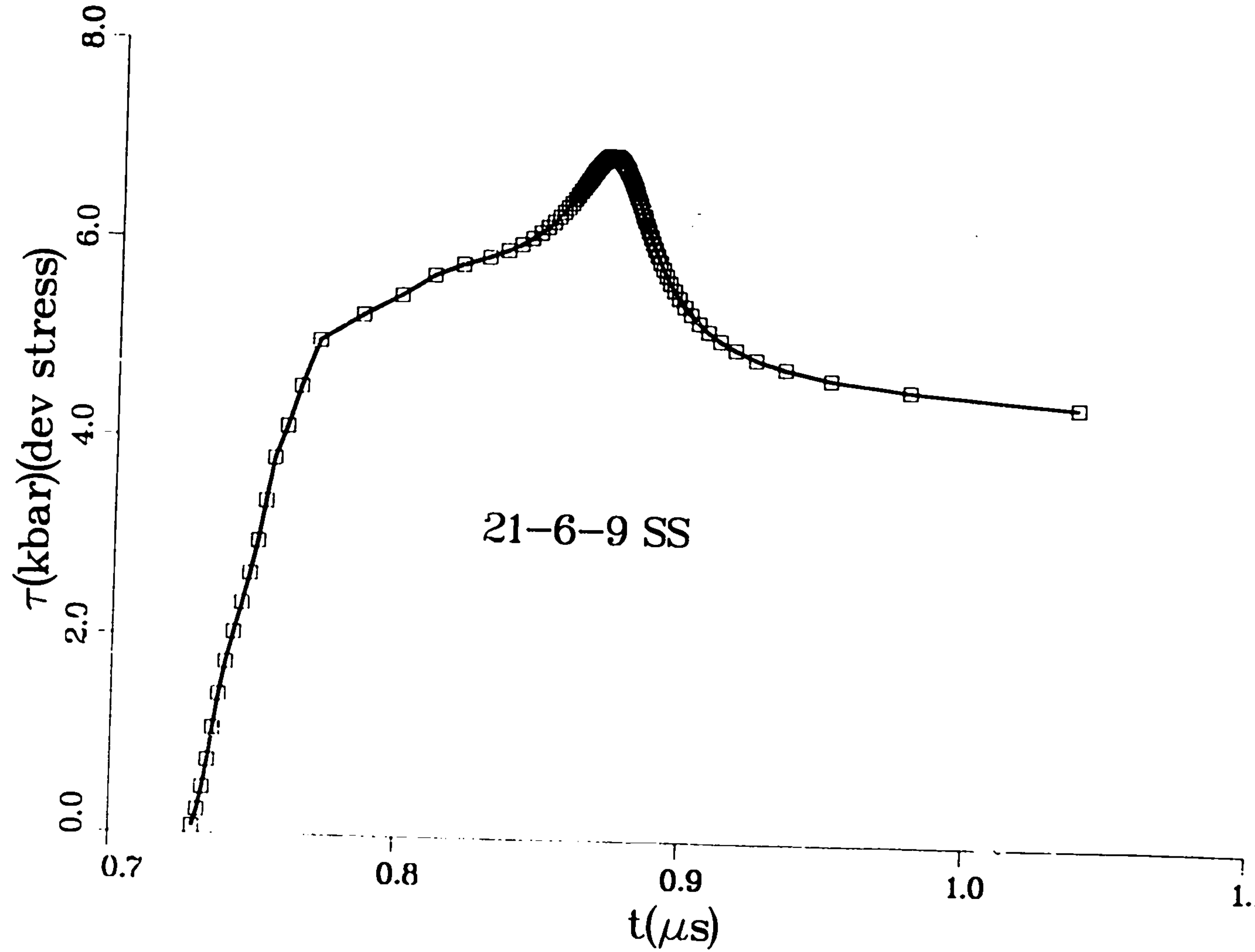

Fig. 40. *In situ* deviatoric stress versus time for shot SSWP1S of 21-6-9 stainless steel. Line is to guide the eye.

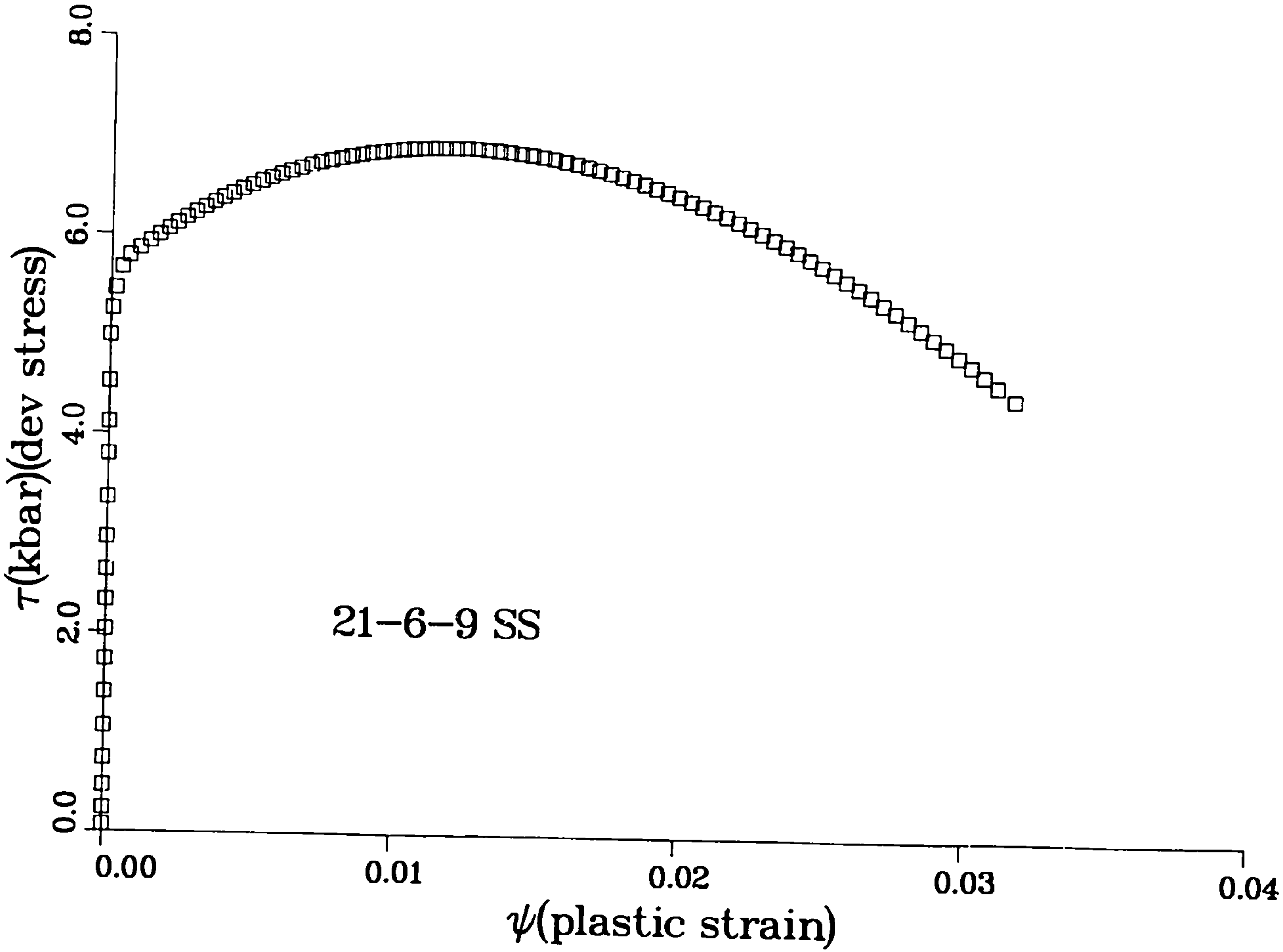

Fig. 41. *In situ* deviatoric stress versus plastic strain for shot SSWP1S of 21-6-9 stainless steel.

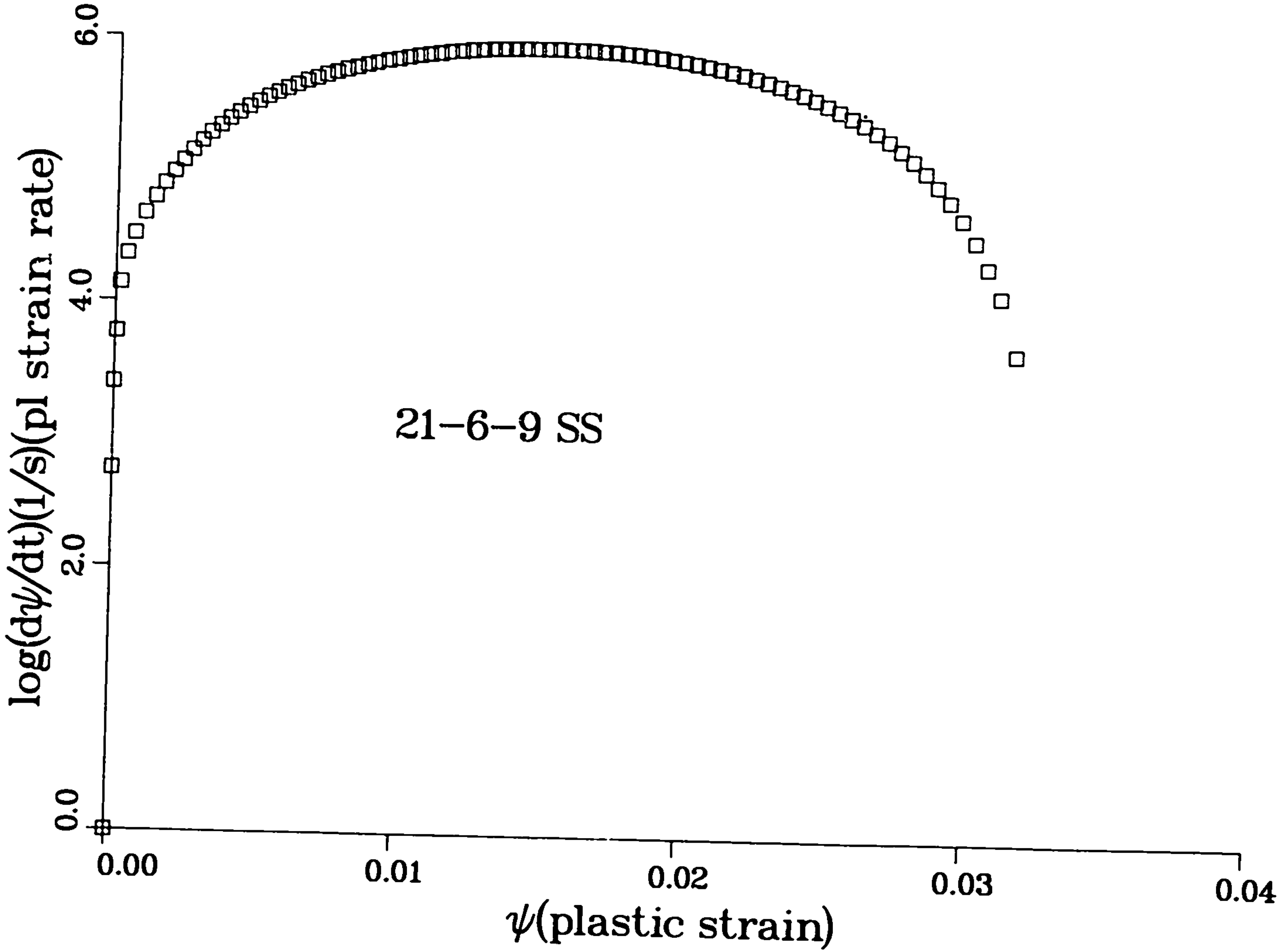

Fig. 42. Log(base 10) of *in situ* plastic strain rate versus plastic strain for shot SSWP1S of 21-6-9 stainless steel.

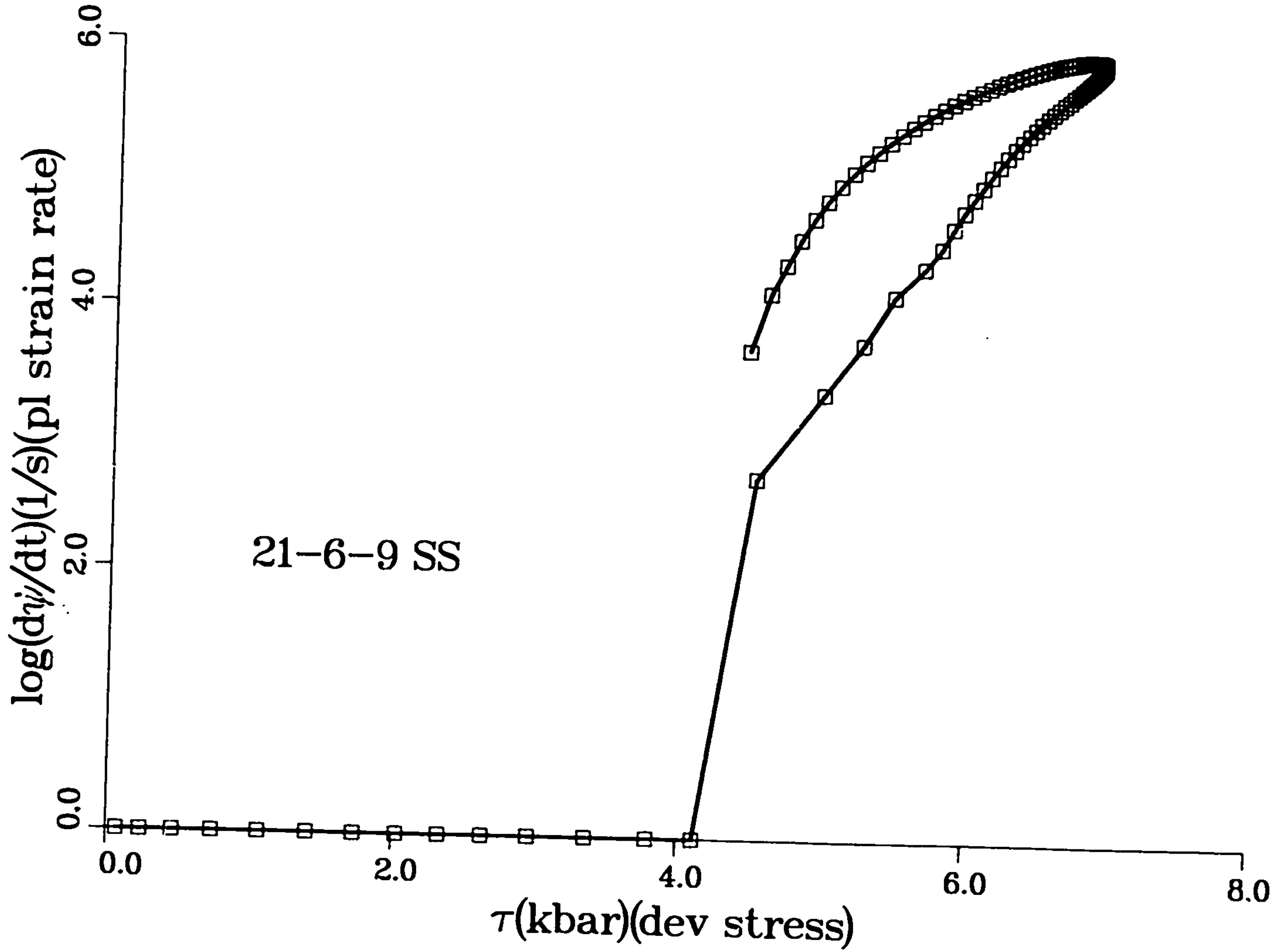

Fig. 43. Log(base 10) of *in situ* plastic strain rate versus deviatoric stress for shot SSWP1S of 21-6-9 stainless steel. Line is to guide the eye.

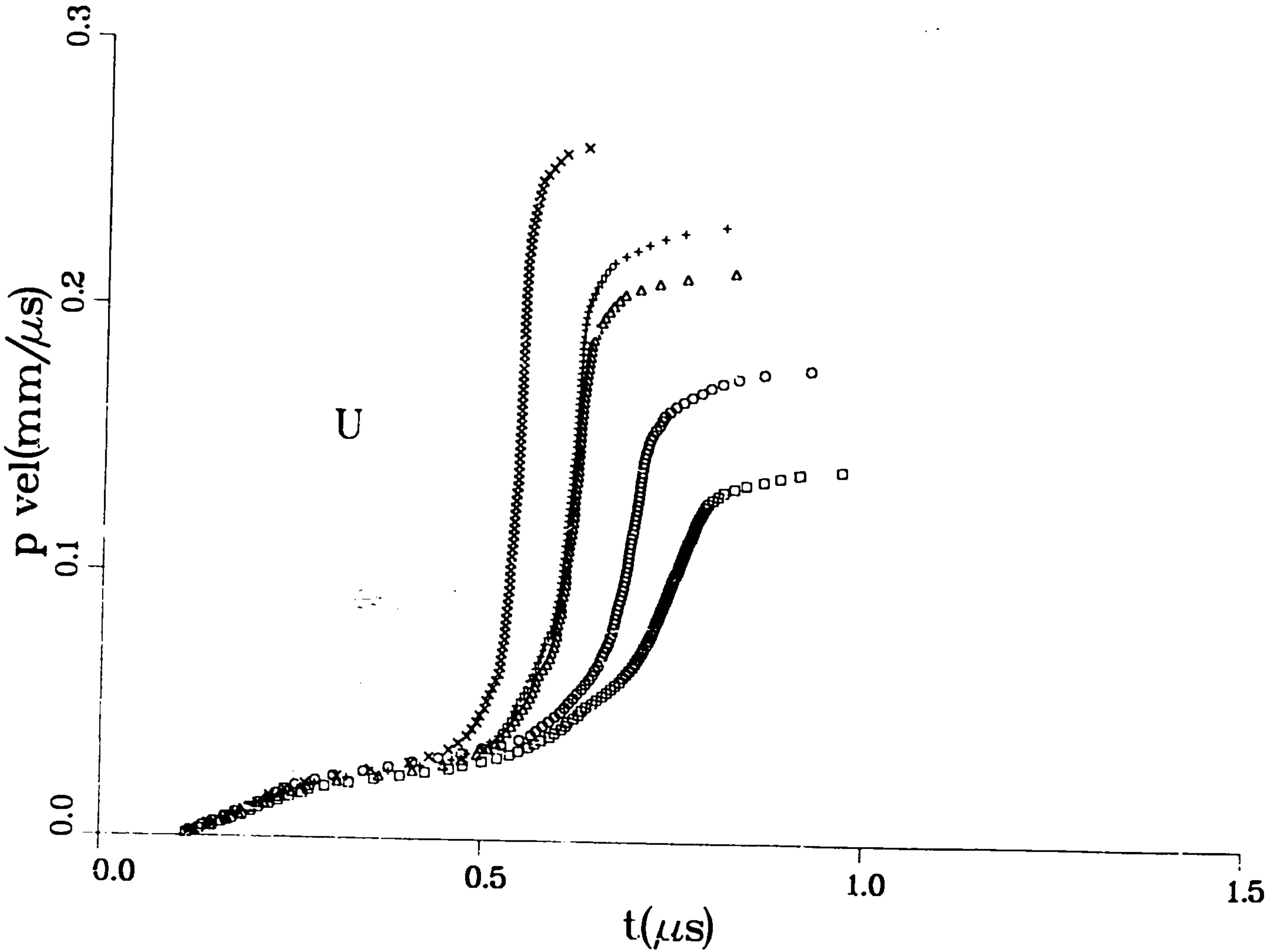

Fig. 44. *In situ* particle velocity versus time for uranium. Squares, circles, triangles, pluses, and Xs are for shots AV6, AV10, AV8, AV7, and AV9, respectively.

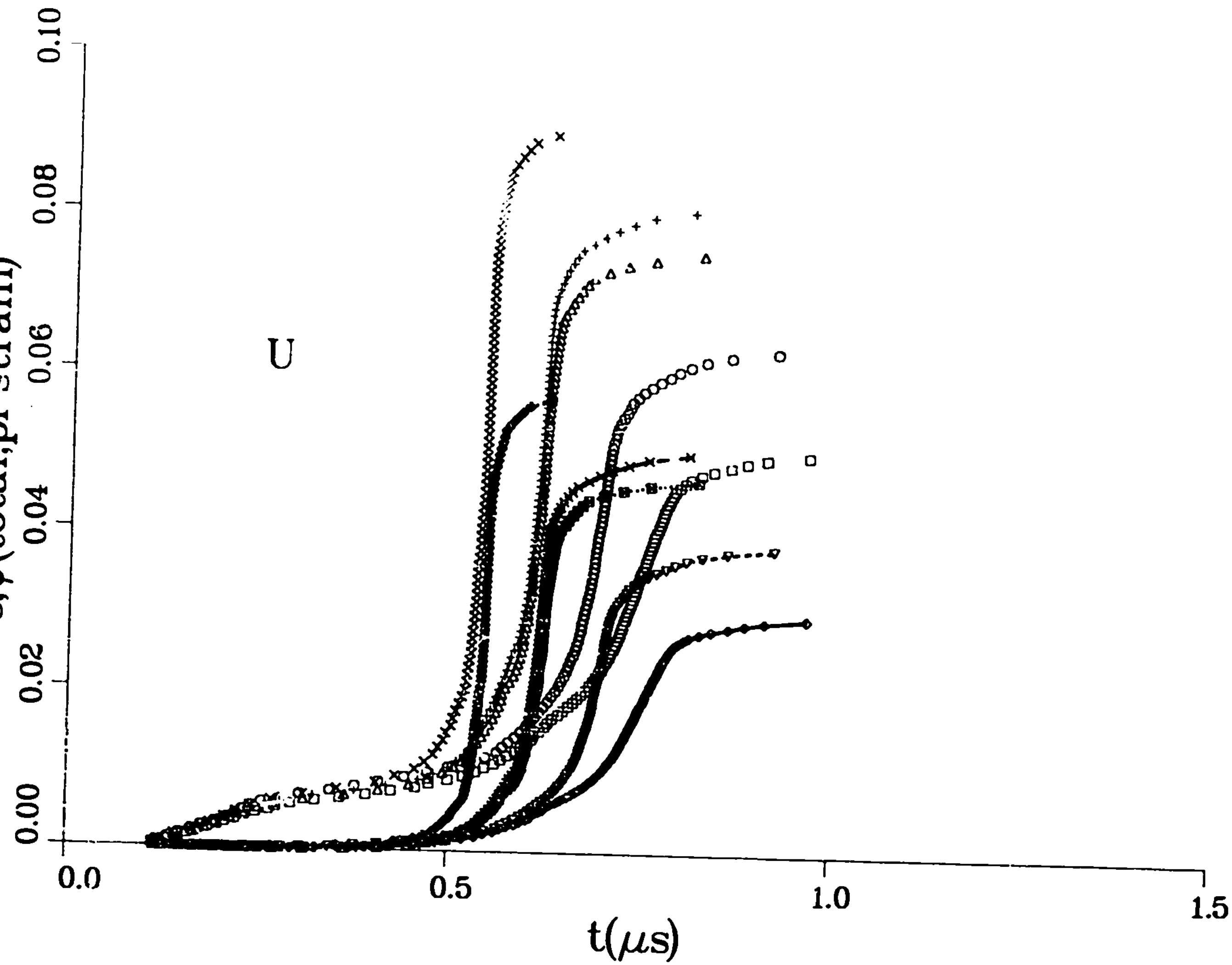

Fig. 45. *In situ* total and plastic strains versus time for uranium. Squares, circles, triangles, pluses, and Xs are total strains for shots AV6, AV10, AV8, AV7, and AV9, respectively. Diamonds, inverted triangles, square-Xs, crossed Xs, and diamond-crosses are plastic strains for the same sequence of shots. Lines are to guide the eye.

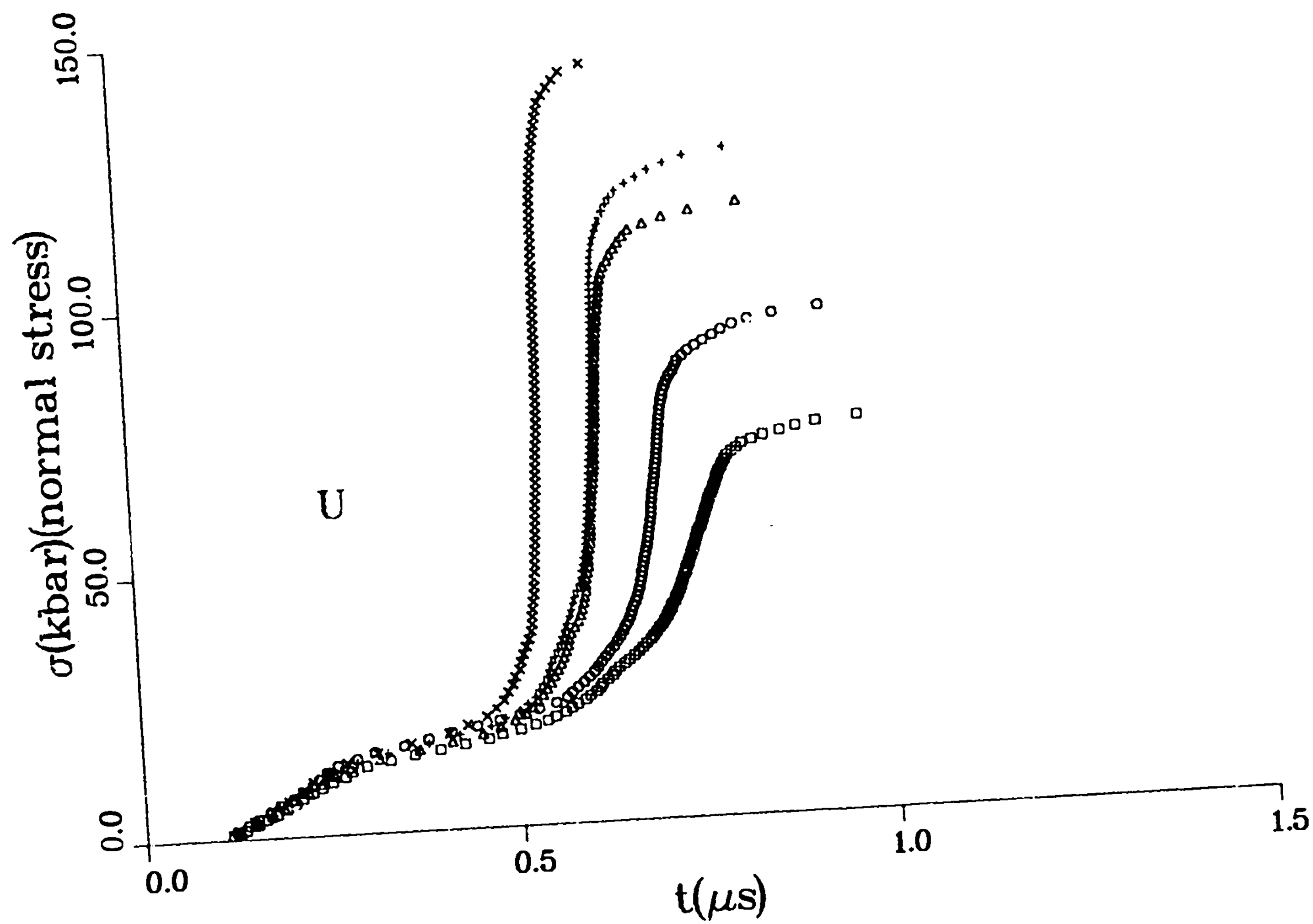

Fig. 46. *In situ* normal stress versus time for uranium. Squares, circles, triangles, crosses, and Xs are for shots AV6, AV10, AV8, AV7, and AV9.

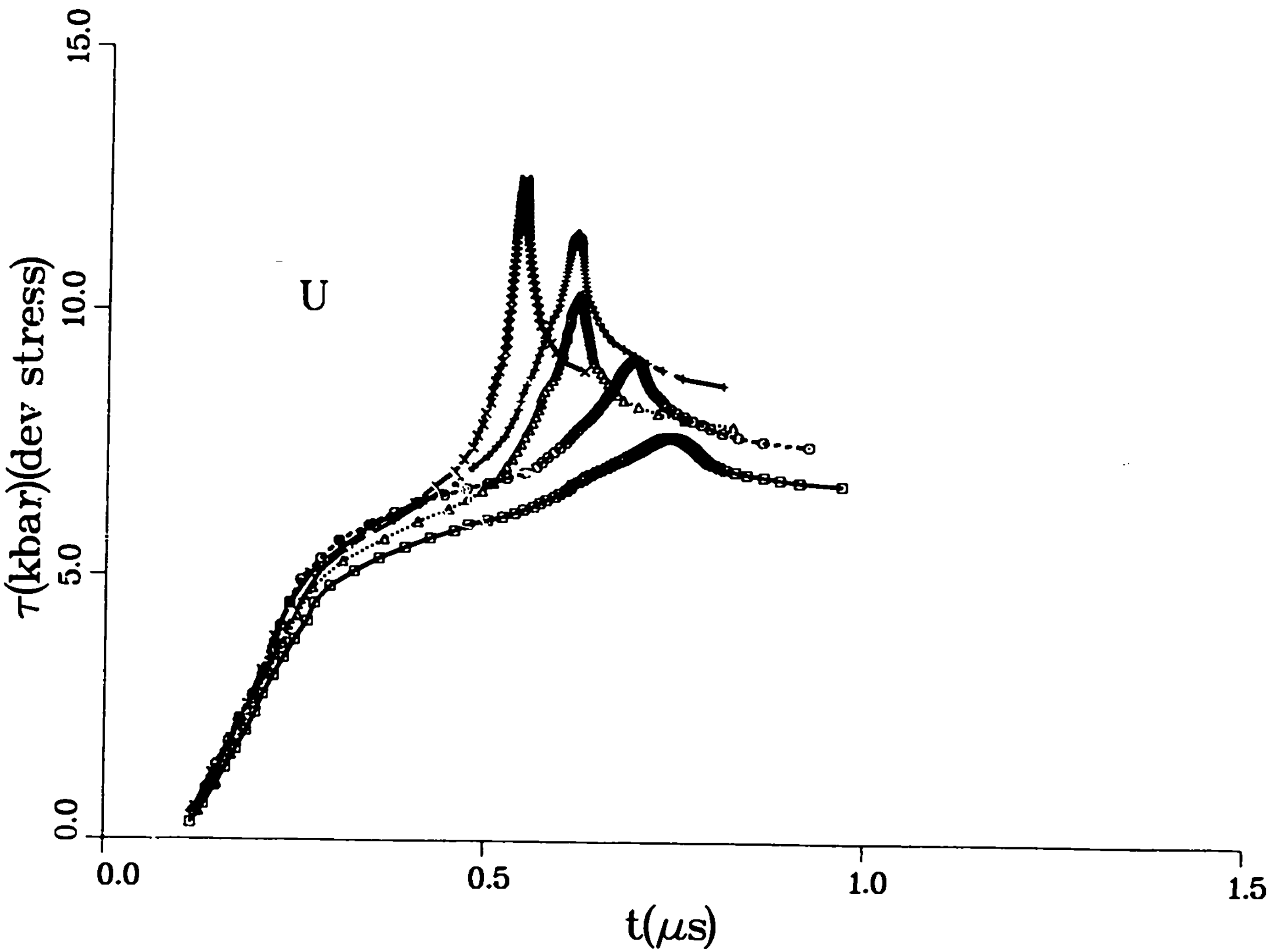

Fig. 47. *In situ* deviatoric stress versus time for uranium. Correspondence between symbols and shots is same as Fig. 46. Lines are to guide the eye.

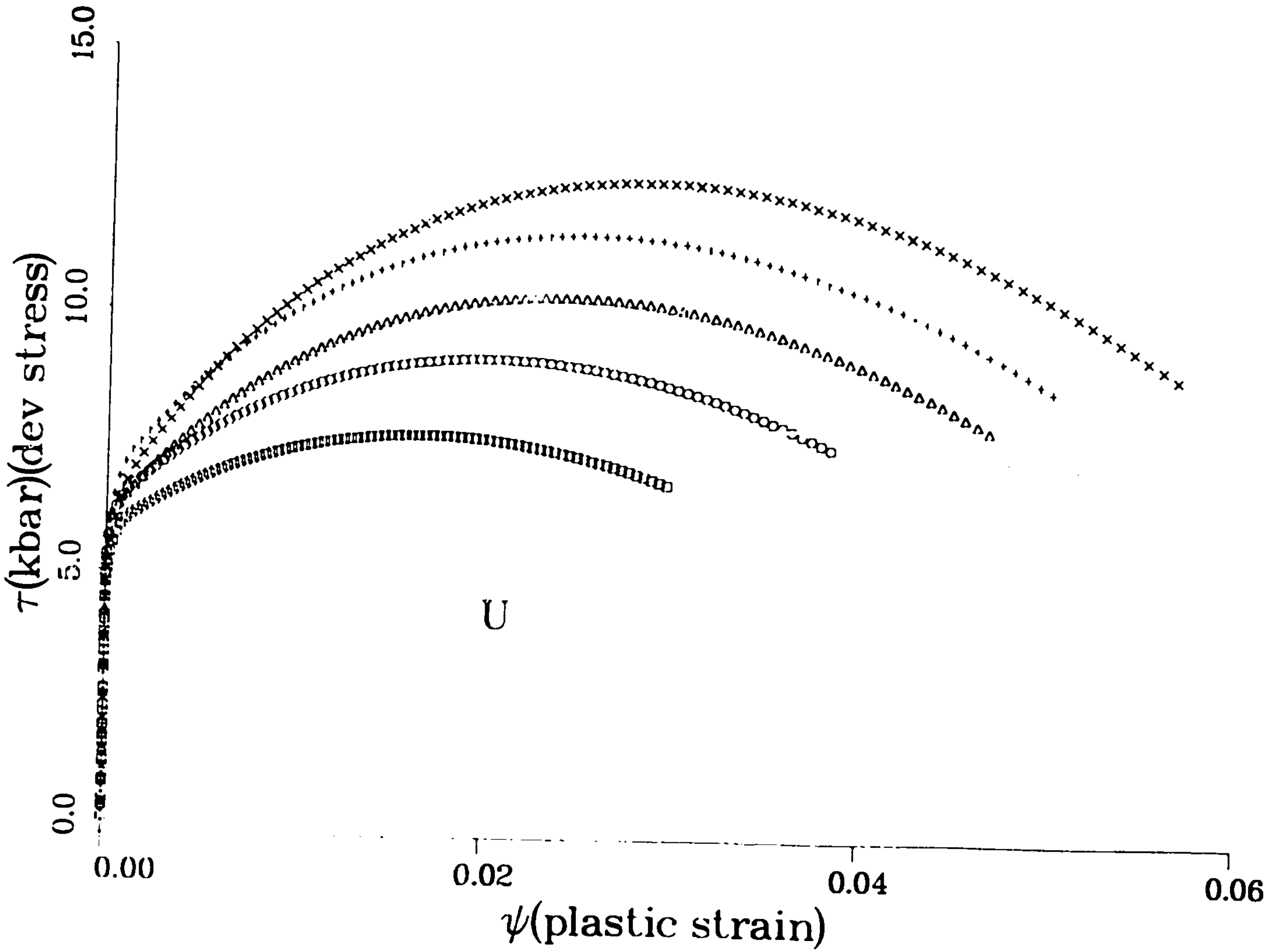

Fig. 48. *In situ* deviatoric stress versus plastic strain for uranium. Correspondence between symbols and shots same as for Fig. 46.

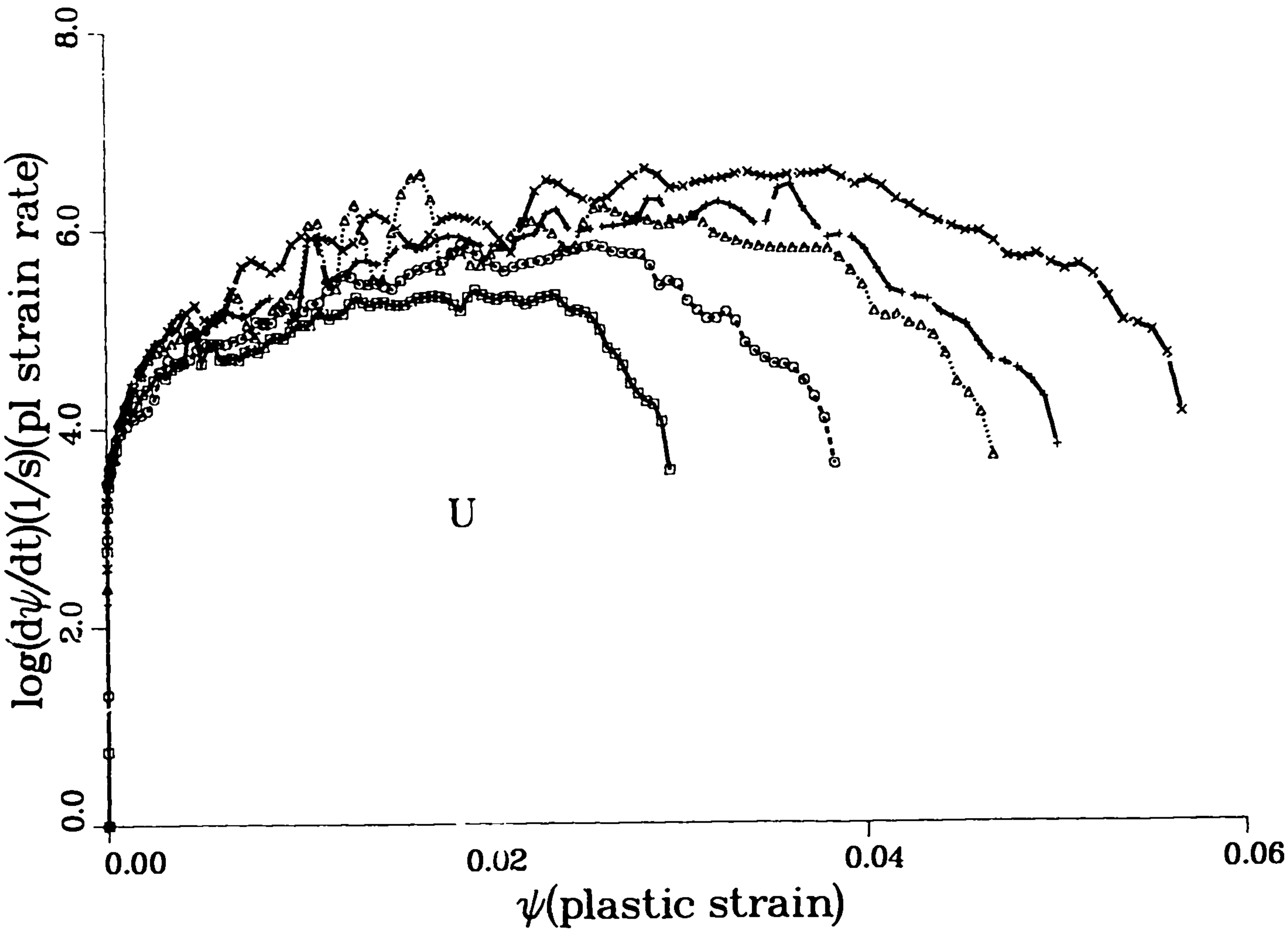

Fig. 49. Log(base 10) of *in situ* plastic strain rate versus plastic strain for uranium. Correspondence between symbols and shots same as for Fig. 46. Lines are to guide the eye.

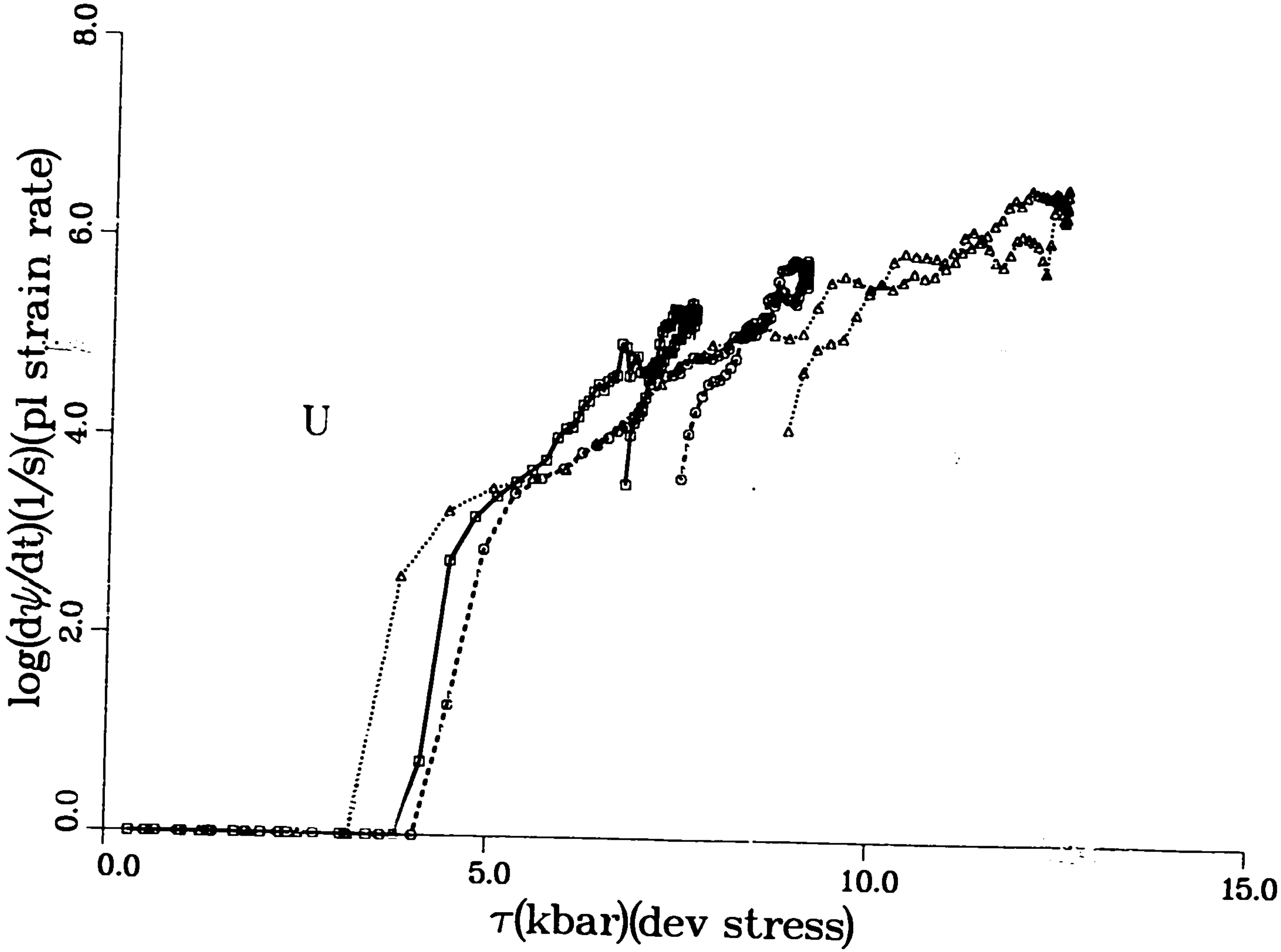

Fig. 5 . Log(base 10) of plastic strain rate versus deviatoric stress for uranium. Squares, circles, and triangles correspond to shots AV6, AV10, and AV9, respectively. Lines are to guide the eye.

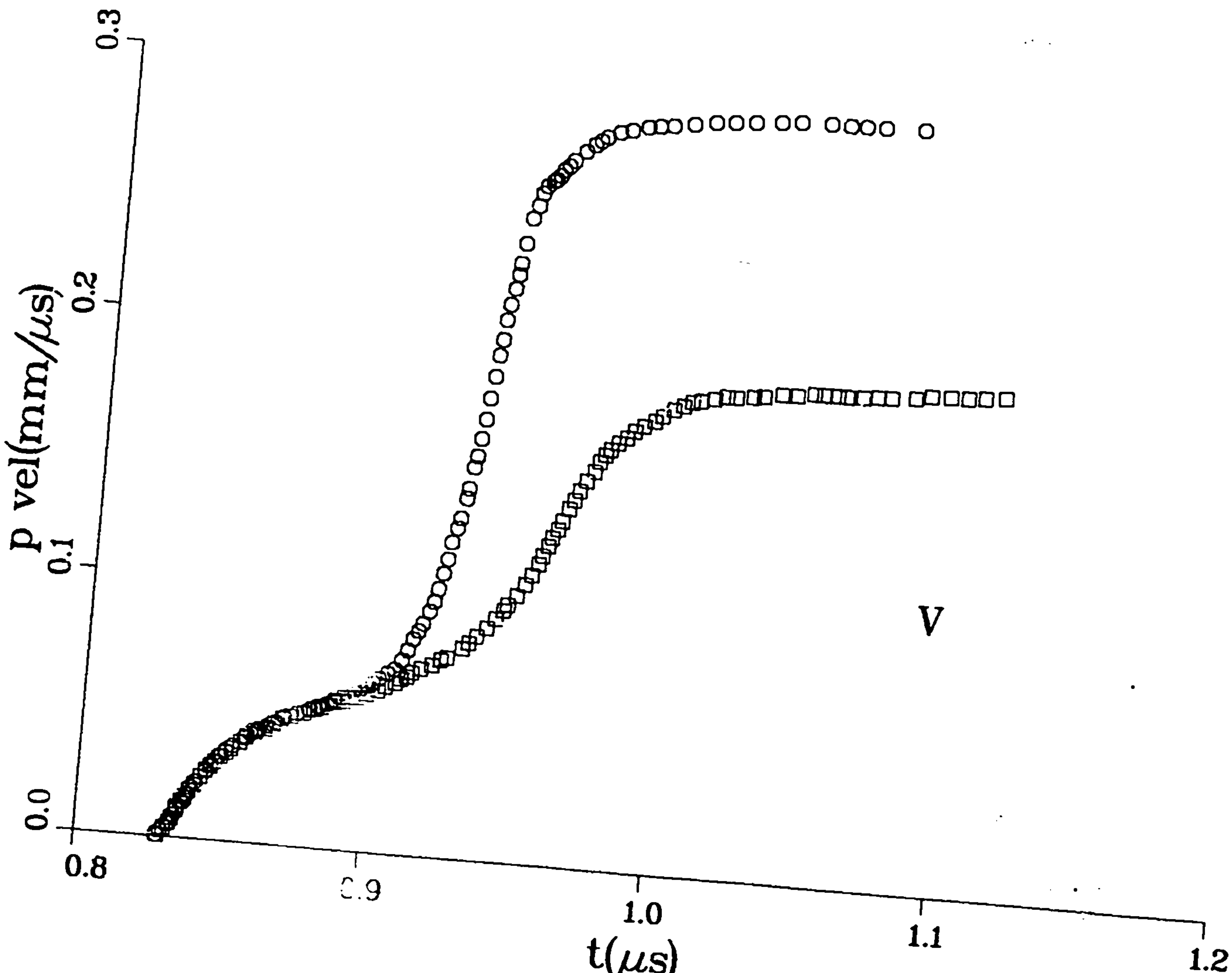

Fig. 51. [illegible] particle velocity versus time for vanadium. Squares and circles are for [illegible] VAN2 and VAN3, respectively.

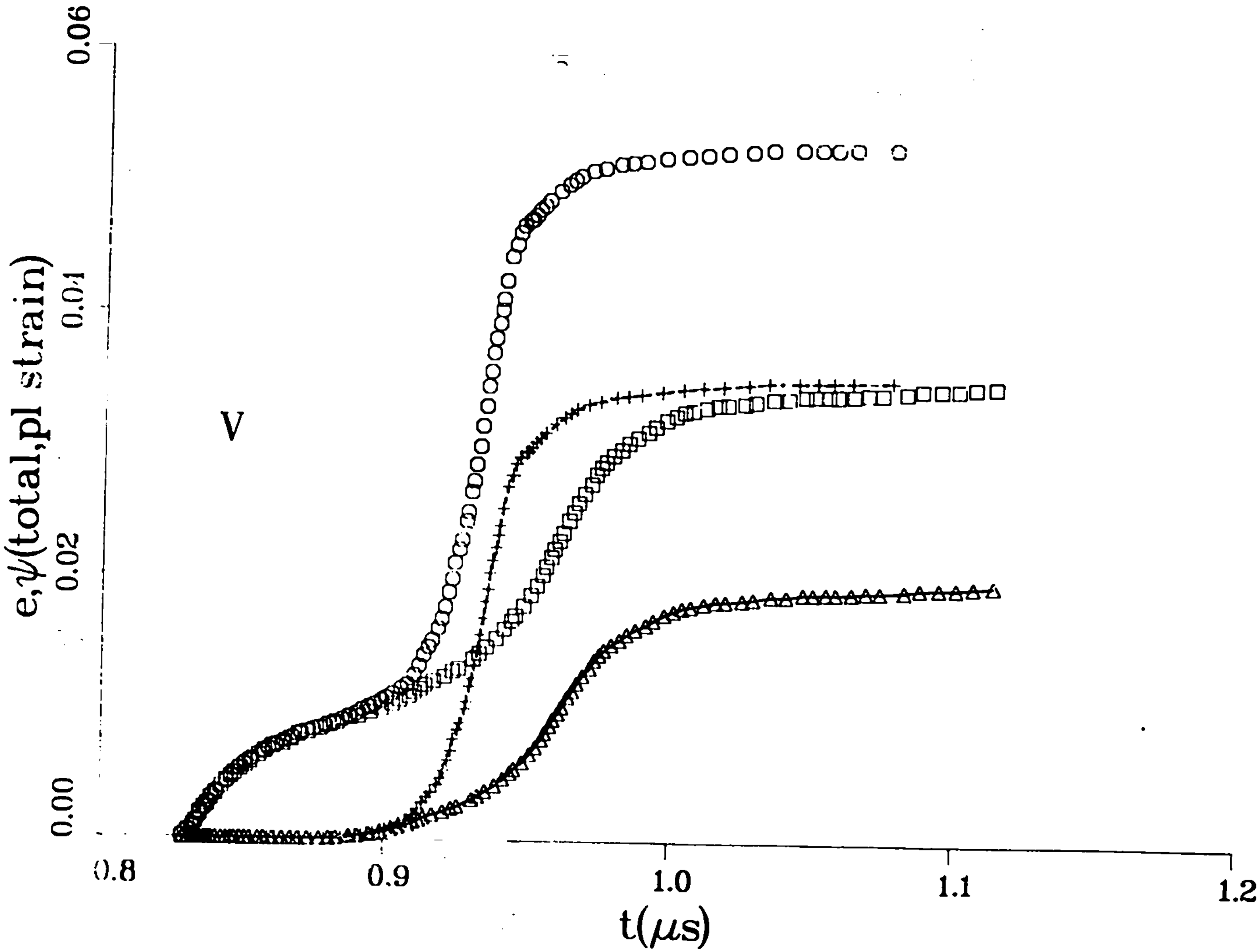

Fig. 52. *In situ* total and plastic strains versus time for vanadium. Squares and circles are total strains for shots VAN2 and VAN3, respectively. Triangles and pluses are plastic strains for shots VAN2 and VAN3, respectively. Lines are to guide the eye.

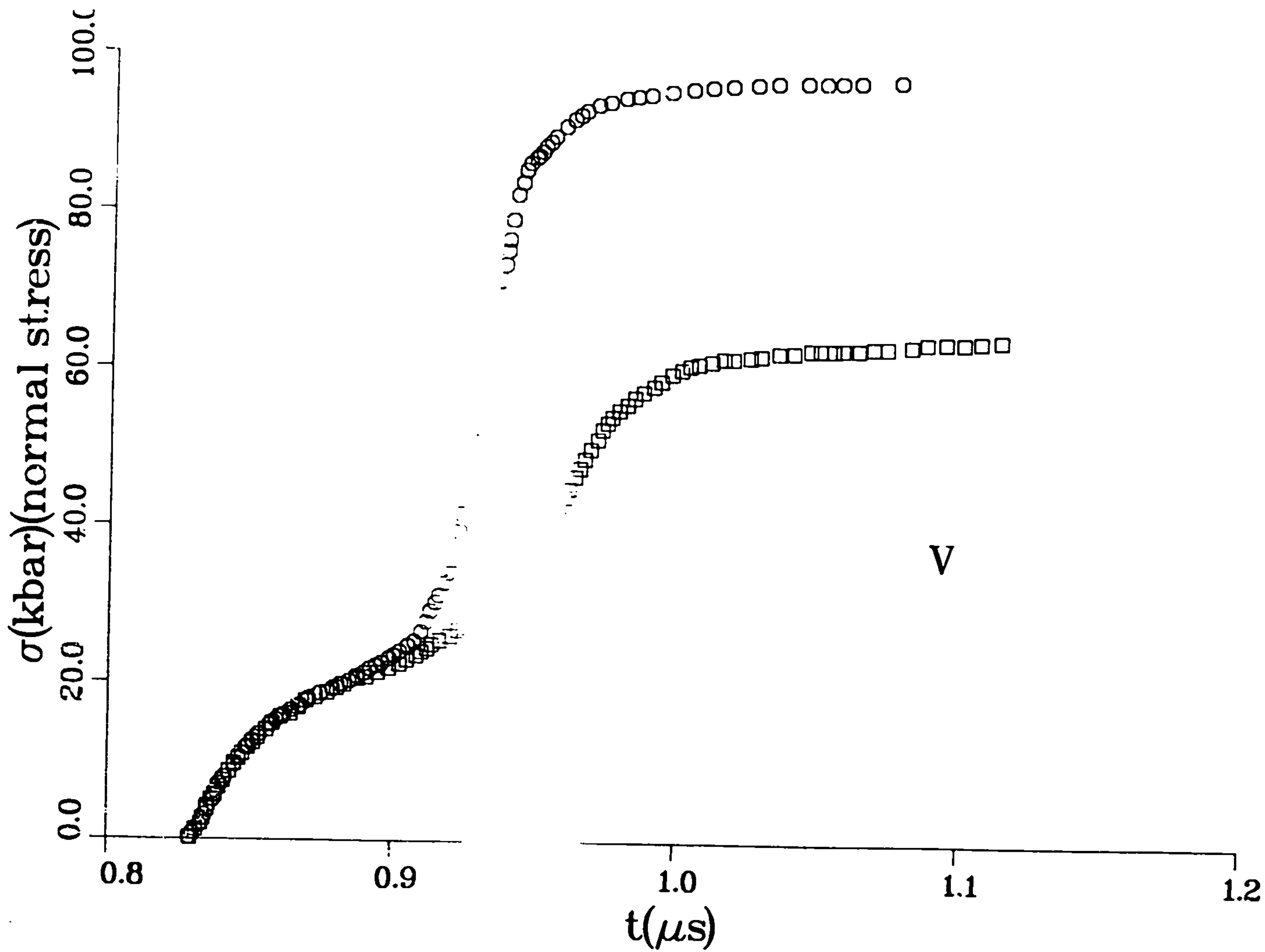

Fig. 53. *In situ* normal stress versus time for vanadium. Squares and circles are for shots VAN2 and VAN3, respectively.

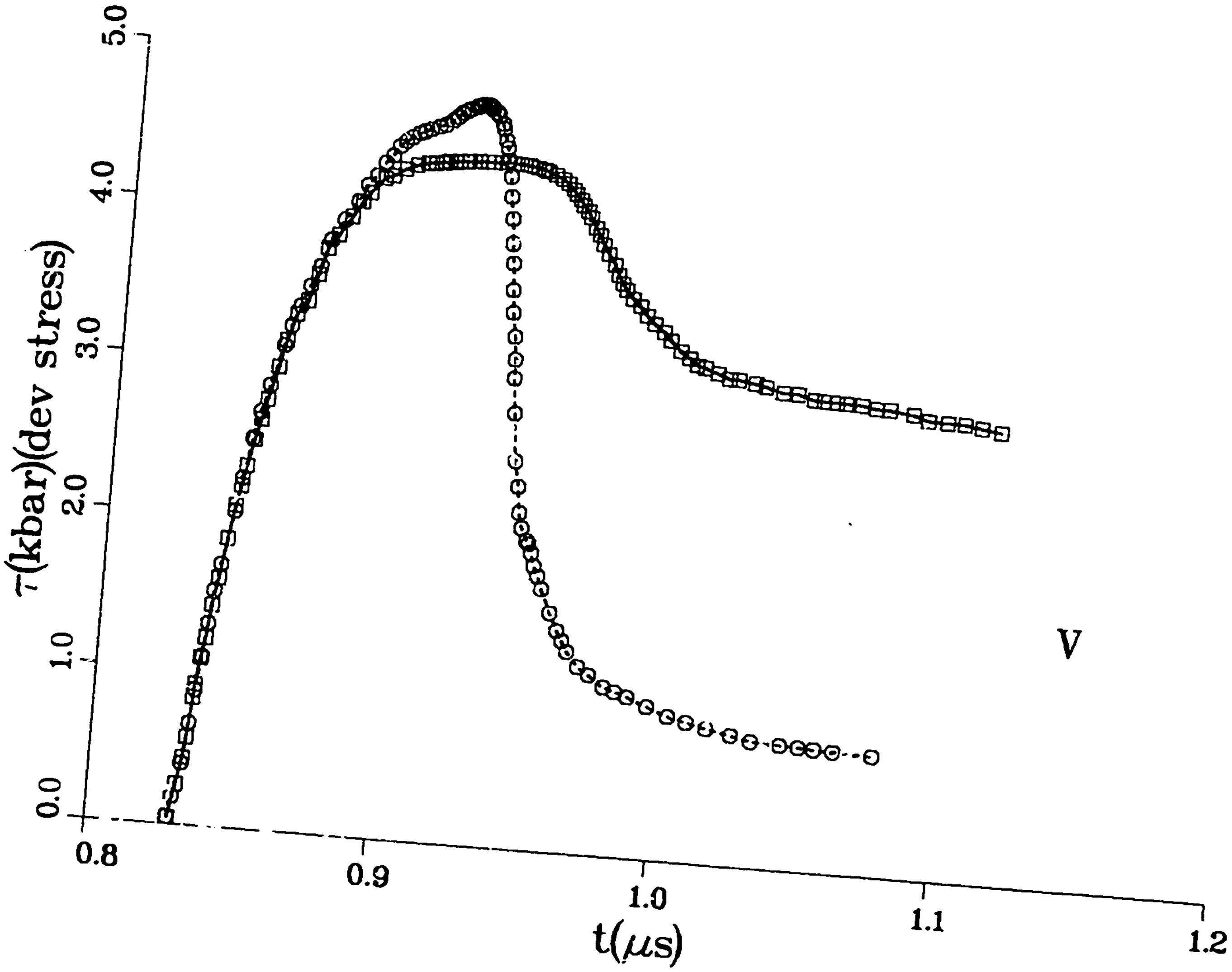

Fig. 54. *In situ* deviatoric stress versus time for vanadium. Squares and circles are for shots VAN2 and VAN3, respectively. Lines are to guide the eye.

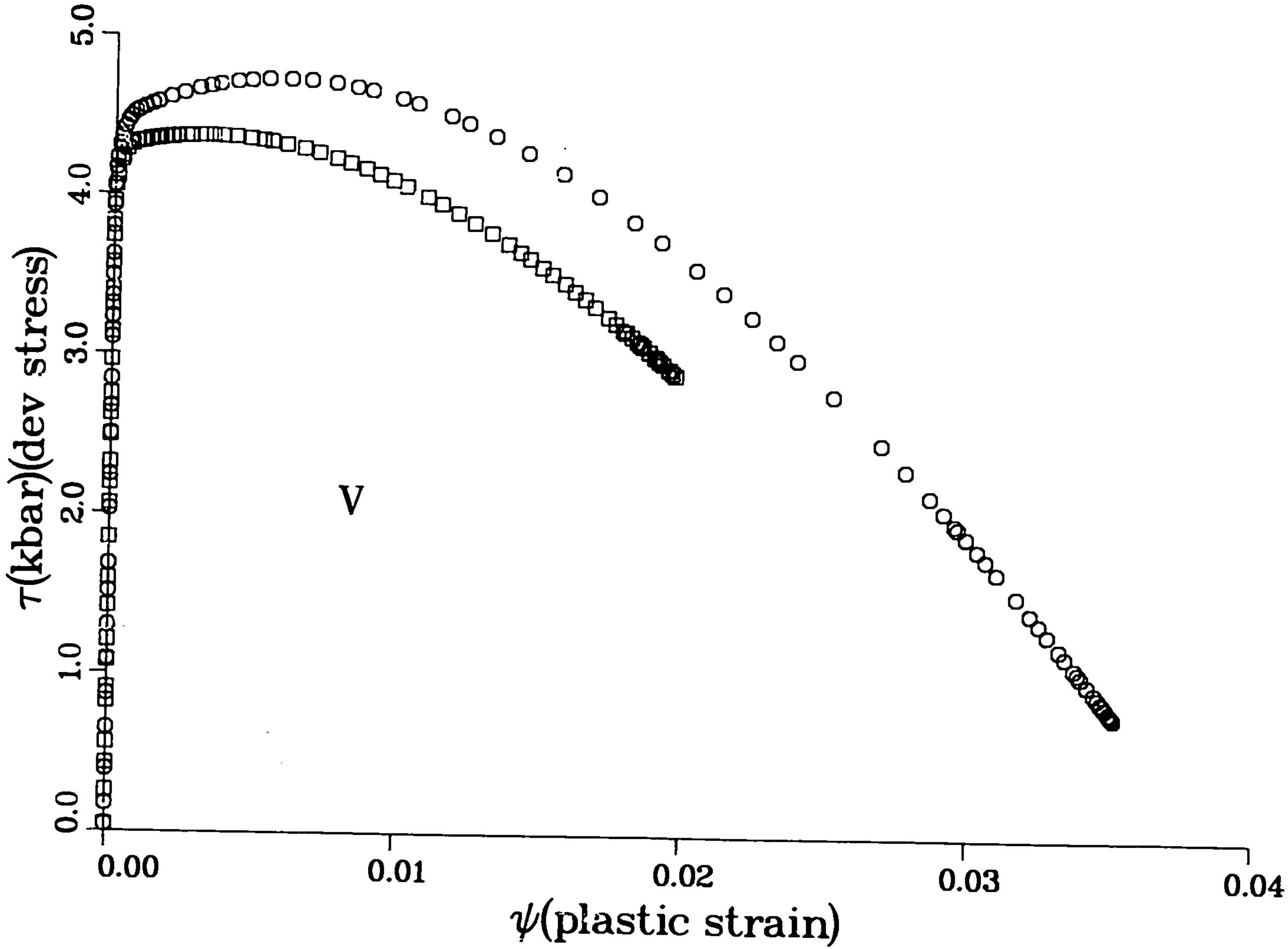

Fig. 55. *In situ* deviatoric stress versus plastic strain for vanadium. Squares and circles are for shots VAN2 and VAN3, respectively.

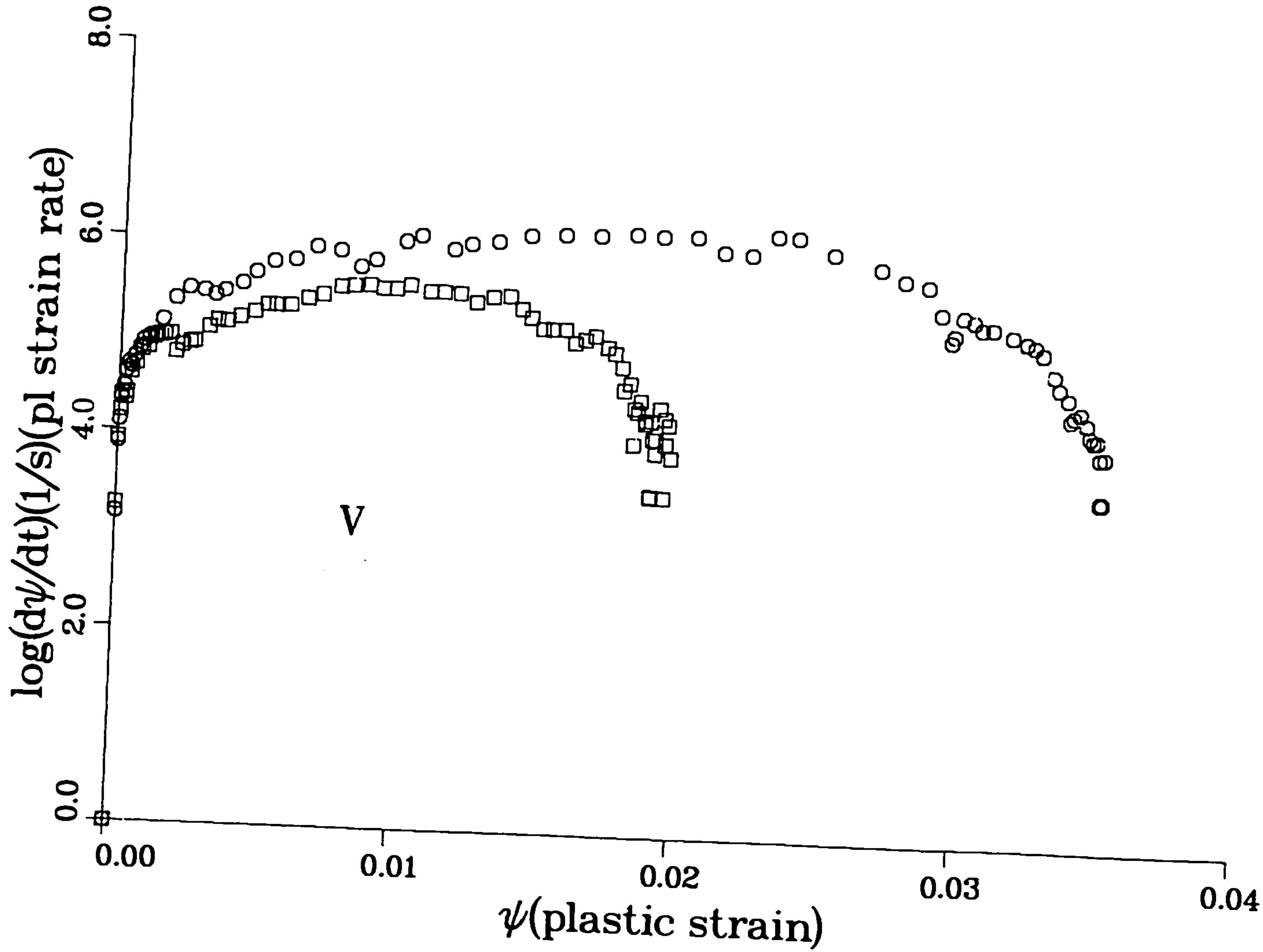

Fig. 56. Log(base 10) of *in situ* plastic strain rate versus plastic strain for vanadium. Squares and circles are for shots VAN2 and VAN3, respectively.

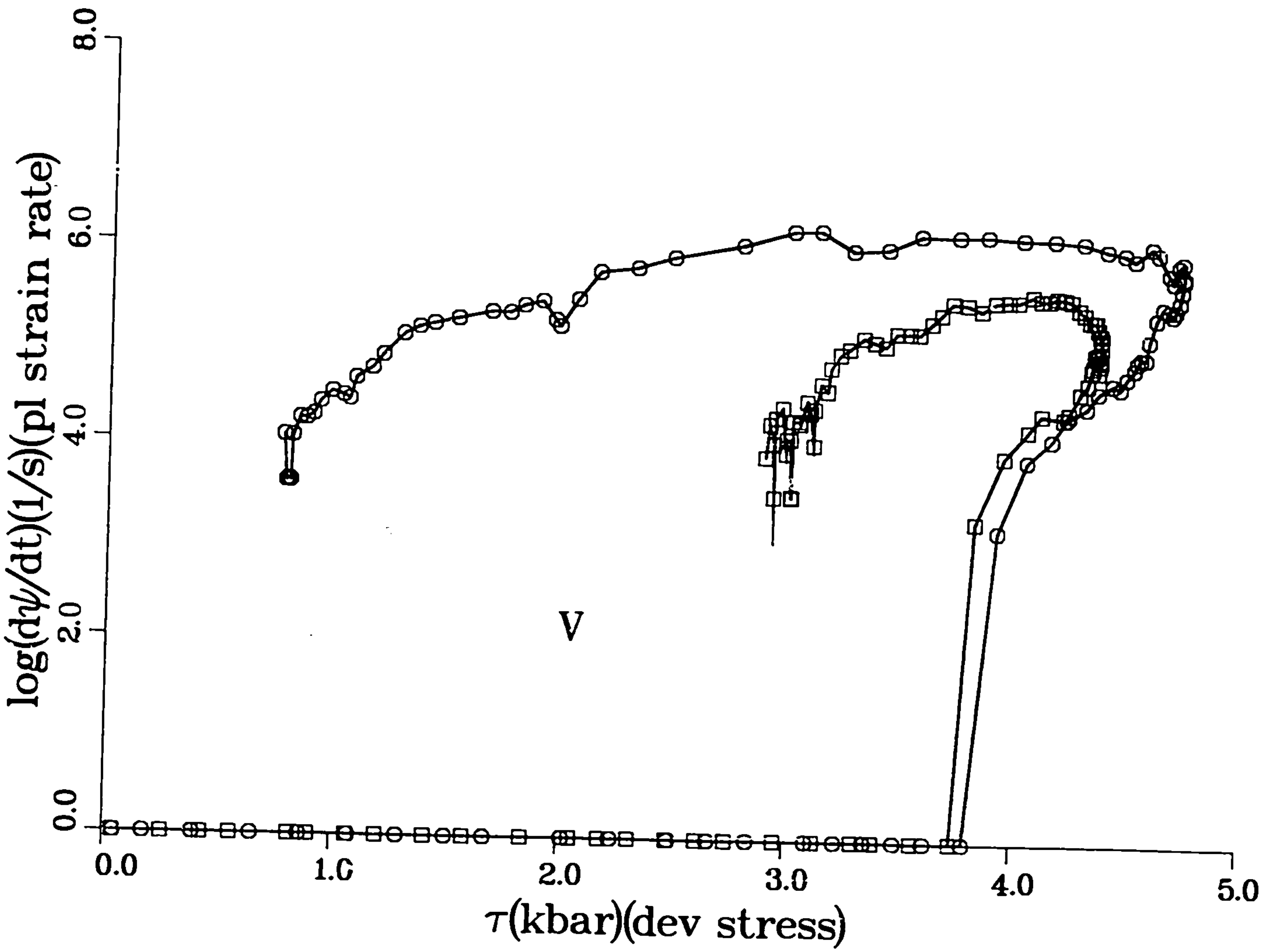

Fig. 57. Log(base 10) of *in situ* plastic strain rate versus deviatoric stress for vanadium. Squares and circles are for shots VAN2 and VAN3, respectively. Lines are to guide the eye.

Appendix A: FORTRAN Subroutine for Reading DataShoP Data Files

```
      subroutine get(nfile,idata,text1,text2,text3,
     1 tsub,vsub,esub,ssub,psub,dsub,hsub)
cc * * * 'Get' reads the information from a DataShoP file into a
cc * * * FORTRAN program.

cc * * * nfile=fortran # for data file.
cc * * * idata=# time 'points' in file.
cc * * * id holds the id information: material, shot strength, and id #.
cc * * * text,text2,text3=dummies to hold text in file.
cc * * * dsam=thickness of sample in experiment.
cc * * * The 'sub' arrays hold data for the shock rise.
cc * * * The prefixes t,v,e,s,p,d,h of the 'sub' arrays refer to
cc * * * time,particle velocity, total strain, normal stress, plastic
cc * * * strain, deviatoric stress, and temperature, respectively.

cc * * * nfile's value  must be supplied by the user, all other values
cc * * *  are read from the DataShoP file.

      dimension tsub(200),vsub(200),esub(200),ssub(200),psub(200),
     1     dsub(200),hsub(200),id(16)
      dimension text1(5),text2(1),text3(12)

       read(nfile,'(2x,16a8/)')id

  990 format(2x,5a8,f5.2,a2)
        read(nfile,990)text1,dsam,text2

      read(nfile,'(5a8,i3,/)')text1,idata

900   format(a12,10a8,1x,a6)
        read(nfile,900)text3
        read(nfile,900)text3
        read(nfile,900)text3
        read(nfile,900)text3

920   format(1x,f11.8,5x,f11.8,5x,f11.7,8x,f8.3,5x,
     $f11.7,8x,f8.3,
     1  4x,f5.0)

      do 700 i=1,idata
        read(nfile,920)tsub(i),vsub(i),esub(i),ssub(i),psub(i),dsub(i),
     1    hsub(i)
700   continue

      return
      end
```

Appendix B: Data Listings by Material and Shot Number

6061T6-Al 21kbar (shot #922)

in situ steady wave: sample thickness=12.50mm
data entries= 16

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.00000000	0.02260000	0.0035184	3.924	0.0000000	0.995	295.
0.04000000	0.02790000	0.0043515	4.835	0.0000642	1.210	296.
0.06800000	0.03140000	0.0049180	5.420	0.0001761	1.328	296.
0.10800000	0.03490000	0.0054976	5.991	0.0003415	1.427	296.
0.18700000	0.04220000	0.0067482	7.143	0.0008523	1.577	297.
0.26000000	0.04950000	0.0080555	8.245	0.0015790	1.652	298.
0.30400000	0.05680000	0.0093911	9.324	0.0024184	1.687	299.
0.34000000	0.06980000	0.0117695	11.244	0.0039518	1.734	301.
0.36000000	0.08170000	0.0139467	13.002	0.0053975	1.759	303.
0.37400000	0.09010000	0.0154835	14.243	0.0064413	1.768	304.
0.40000000	0.10680000	0.0185389	16.711	0.0085726	1.761	306.
0.43000000	0.11980000	0.0209173	18.631	0.0102816	1.733	308.
0.46200000	0.12730000	0.0222895	19.739	0.0112869	1.709	309.
0.50000000	0.13290000	0.0233140	20.567	0.0120466	1.686	310.
0.56000000	0.13860000	0.0243569	21.409	0.0128276	1.660	310.
0.57500000	0.14000000	0.0246130	21.616	0.0130207	1.653	311.

6061T6-Al 21kbar (shot #939)

in situ steady wave: sample thickness=31.60mm
data entries= 14

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.01630000	0.02290000	0.0035647	3.976	0.0000000	1.008	295.
0.03130000	0.02720000	0.0042385	4.718	0.0000433	1.136	296.
0.24400000	0.03150000	0.0049325	5.438	0.0001726	1.333	296.
[illegible]4630000	0.04040000	0.0064231	6.866	0.0007000	1.549	297.
[illegible]50000	0.04930000	0.0080203	8.215	0.0015603	1.649	298.
0.[illegible]7280000	0.05820000	0.0096692	9.543	0.0026046	1.689	299.
0 [illegible]1330000	0.06730000	0.0113181	10.871	0.0036725	1.719	301
0.[illegible]4090000	0.07620000	0.0129486	12.184	0.0047511	1.740	302.
0.86700000	0.08520000	0.0145975	13.511	0.0058643	1.752	303.
0.88870000	0.09420000	0.0162463	14.839	0.0069994	1.754	304.
0.91610000	0.10320000	0.0178952	16.167	0.0081560	1.747	306.
0.95210000	0.11210000	0.0195257	17.480	0.0093205	1.732	307.
1.04440000	0.12110000	0.0211746	18.808	0.0105186	1.706	308.
1.25550000	0.13490000	0.0237029	20.844	0.0123947	1.650	310.

6061T6-Al 37kbar (shot #936)

in situ steady wave: sample thickness= 6.13mm
data entries= 18

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.00000000	0.02260000	0.0035184	3.924	0.0000000	0.995	295.
0.01000000	0.02960000	0.0046203	5.126	0.0000937	1.276	296.
0.02000000	0.03480000	0.0054666	5.990	0.0002824	1.443	296.
0.04000000	0.03920000	0.0062010	6.702	0.0005181	1.559	297.
0.08000000	0.04330000	0.0069005	7.352	0.0007990	1.646	297.
0.11000000	0.05010000	0.0080930	8.400	0.0013911	1.745	298.
0.13000000	0.06190000	0.0101972	10.189	0.0025740	1.863	300.
0.13500000	0.07100000	0.0118200	11.568	0.0035148	1.944	301.
0.13800000	0.10350000	0.0176155	16.494	0.0070672	2.156	305.
0.14000000	0.12520000	0.0214851	19.784	0.0095980	2.232	308.
0.14200000	0.14860000	0.0256578	23.331	0.0124605	2.258	312.
0.14400000	0.17200000	0.0298306	26.878	0.0154544	2.223	315.
0.14700000	0.20720000	0.0361075	32.213	0.0201909	2.061	320.
0.15000000	0.21660000	0.0377838	33.638	0.0215010	1.995	321.
0.16000000	0.22370000	0.0390499	34.714	0.0225028	1.939	322.
0.19000000	0.22920000	0.0400307	35.548	0.0232859	1.892	323.
0.23000000	0.23290000	0.0406904	36.109	0.0238161	1.850	323.
0.29000000	0.23660000	0.0413502	36.669	0.0243492	1.8[illegible]4	324.

6061T6-Al 37kbar (shot #927)

in situ steady wave: sample thickness=12.20mm
data entries= 21

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.00000000	0.02610000	0.0040579	4.538	0.0000000	1.151	296.
0.02500000	0.02780000	0.0043211	4.834	0.0000057	1.226	296.
0.07600000	0.03140000	0.0048882	5.452	0.0000611	1.368	296.
0.12600000	0.03490000	0.0054521	6.039	0.0001682	1.489	296.
0.17700000	0.03850000	0.0060450	6.630	0.0003317	1.594	297.
0.21000000	0.04220000	0.0066681	7.224	0.0005546	1.683	297.
0.23300000	0.04580000	0.0072875	7.790	0.0008238	1.751	298.
0.24800000	0.05000000	0.0080268	8.435	0.0012013	1.809	298.
0.26000000	0.05310000	0.0085791	8.905	0.0015063	1.842	299.
0.28000000	0.06870000	0.0113582	11.272	0.0030854	1.993	301.
0.28600000	0.08690000	0.0146004	14.033	0.0050176	2.134	303.
0.29000000	0.10770000	0.0183058	17.189	0.0073387	2.252	306.
0.29200000	0.12680000	0.0217084	20.087	0.0095711	2.317	308.
0.29400000	0.14590000	0.0251110	22.985	0.0118956	2.343	311.
0.29600000	0.16510000	0.0285314	25.899	0.0143209	2.330	314.
0.29800000	0.18420000	0.0319340	28.797	0.0168182	2.277	317.
0.30000000	0.20330000	0.0353366	31.695	0.0193965	2.185	319.
0.31000000	0.22250000	0.0387569	34.608	0.0220667	2.053	322.
0.35000000	0.22980000	0.0400574	35.716	0.0231019	1.993	323.
0.46000000	0.23730000	0.0413935	36.854	0.0241768	1.925	324.
0.60000000	0.24040000	0.0419458	37.324	0.0246243	1.895	325.

6061T6-Al 37kbar (shot #937)

in situ steady wave: sample thickness=37.90mm
data entries= 24

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.00000000	0.02310000	0.0035955	4.011	0.0000000	1.019	295.
0.07000000	0.02440000	0.0037968	4.238	0.0000025	1.074	295.
0.17000000	0.02610000	0.0040621	4.533	0.0000156	1.146	296.
0.26000000	0.02790000	0.0043454	4.842	0.0000406	1.218	296.
0.44000000	0.03150000	0.0049198	5.452	0.0001244	1.350	296.
0.62000000	0.03510000	0.0055046	6.051	0.0002524	1.468	296.
0.73000000	0.03880000	0.0061162	6.656	0.0004290	1.573	297.
0.79000000	0.04240000	0.0067218	7.234	0.0006438	1.660	297.
0.84000000	0.04790000	0.0076669	8.100	0.0010520	1.765	298.
0.85200000	0.05000000	0.0080341	8.424	0.0012328	1.797	298.
0.87200000	0.05340000	0.0086360	8.943	0.0015544	1.839	299.
0.90000000	0.06080000	0.0099560	10.065	0.0023010	1.911	300.
0.91000000	0.08270000	0.0138627	13.383	0.0046051	2.089	303.
0.91300000	0.10650000	0.0181082	16.990	0.0072620	2.224	306.
0.91600000	0.13020000	0.0223359	20.581	0.0100570	2.295	309.
0.92000000	0.16190000	0.0279906	25.384	0.0140135	2.296	313.
0.92300000	0.18570000	0.0322362	28.990	0.0171387	2.224	317.
0.92700000	0.20490000	0.0356612	31.900	0.0197514	2.123	320.
0.93300000	0.21580000	0.0376055	33.551	0.0212698	2.048	321.
0.95000000	0.22290000	0.0388721	34.627	0.0222721	1.992	322.
0.96700000	0.22650000	0.0395142	35.173	0.0227842	1.961	323.
1.00300000	0.23010000	0.0401564	35.718	0.0232991	1.930	323.
1.06000000	0.23460000	0.0409591	36.400	0.0239463	1.888	324.
1.08000000	0.23530000	0.0410840	36.506	0.0240473	1.881	324.

6061T6-Al 89kbar (shot #926)

in situ steady wave: sample thickness=12.50mm
data entries= 16

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.00000000	0.02430000	0.0037806	4.222	0.0000000	1.071	295.
0.02160000	0.02680000	0.0041674	4.659	0.0000061	1.181	296.
0.05700000	0.03480000	0.0054231	6.036	0.0001158	1.503	296.
0.08810000	0.04190000	0.0065605	7.234	0.0003231	1.751	297.
0.10330000	0.05000000	0.0078843	8.574	0.0006816	1.994	298.
0.11650000	0.05700000	0.0090405	9.720	0.0010550	2.181	299.
0.11980000	0.07210000	0.0115346	12.191	0.0019171	2.570	301.
0.12030000	0.08720000	0.0140286	14.662	0.0028537	2.934	302.
0.12130000	0.17180000	0.0280020	28.507	0.0093239	4.557	314.
0.12230000	0.25640000	0.0419753	42.351	0.0175681	5.481	326.
0.12330000	0.34100000	0.0559486	56.196	0.0272750	5.724	340.
0.12430000	0.42560000	0.0699220	70.041	0.0382250	5.303	355.
0.12530000	0.51020000	0.0838953	83.886	0.0502536	4.231	369.
0.12670000	0.52530000	0.0863894	86.357	0.0525043	3.972	372.
0.12830000	0.53800000	0.0884870	88.435	0.0544201	3.738	374.
0.15940000	0.54040000	0.0888834	88.828	0.0547845	3.692	375.

Be-63 kbar(shot# Be18)

in situ steady wave: sample thickness= 8.00mm
data entries= 98

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.29060000	0.00000000	0.0000000	0.000	0.0000000	0.000	293.
0.36910000	0.00006000	0.0000046	0.015	0.0000000	0.007	293.
0.42510000	0.00010000	0.0000076	0.024	0.0000000	0.011	293.
0.44770000	0.00012000	0.0000091	0.029	0.0000000	0.014	293.
0.53130000	0.00023000	0.00[illegible]175	0.056	0.0000001	0.02[illegible]	293.
0.55200000	0.00026000	0.0000198	0.063	0.0000001	0.030	293.
0.57850000	0.00034000	0.0000260	0.082	0.0000001	0.039	293.
0.59610000	0.00040000	0.0000306	0.097	0.0000002	0.046	293.
0.60180000	0.00131000	0.0001007	0.315	0.0000020	0.147	293.
0.60370000	0.00161000	0.0001241	0.387	0.0000030	0.180	293.
0.61970000	0.00411000	0.0003224	0.970	0.0000194	0.442	293.
0.62580000	0.00470000	0.0003702	1.105	0.0000254	0.501	293.
0.63380000	0.00551000	0.0004364	1.288	0.0000347	0.580	293.
0.64970000	0.00675000	0.0005393	1.565	0.0000519	0.696	293.
0.65290000	0.00701000	0.0005611	1.622	0.0000559	0.720	293.
0.66630000	0.00846000	0.0006839	1.939	0.0000809	0.848	293.
0.67360000	0.00902000	0.0007320	2.060	0.0000918	0.896	293.
0.67780000	0.00944000	0.0007682	2.150	0.0001004	0.932	293.
0.68870000	0.01047000	0.0006580	2.369	0.0001230	1.016	293.
0.69760000	0.01126000	0.0009277	2.535	0.0001419	1.078	293.
0.70340000	0.01202000	0.0009953	2.693	0.0001613	1.137	293.
0.71570000	0.01355000	0.0011335	3.006	0.0002038	1.249	293.
0.71620000	0.01361000	0.0011390	3.018	0.0002056	1.253	293.
0.73270000	0.01556000	0.0013189	3.410	0.0002669	1.386	293.
0.73350000	0.01565000	0.0013[illegible]	3.427	0.0002699	1.392	293.
0.74990000	0.01774000	0.001[illegible]	3.836	0.0003444	1.522	294.
0.75690000	0.01875000	0.001[illegible]	4.030	0.0003834	1.581	294.
0.76370000	0.01974000	0.0017189	4.218	0.0004236	1.636	294.
0.77720000	0.02115000	0.0018581	4.483	0.0004841	1.709	294.
0.77820000	0.02127000	0.0018701	4.505	0.0004894	1.715	294.
0.78810000	0.02261000	0.0020047	4.752	0.0005507	1.780	294.
0.79180000	0.02333000	0.0020778	4.883	0.0005851	1.813	294.
0.79460000	0.02389000	0.0021351	4.984	0.0006124	1.838	294.
0.80190000	0.02547000	0.0022985	5.267	0.0006928	1.903	294.
0.80450000	0.02607000	0.0023613	5.373	0.0007245	1.926	294.
0.81340000	0.02714000	0.0024743	5.561	0.0007828	1.966	294.
0.81770000	0.02777000	0.0025414	5.670	0.0008189	1.987	294.
0.82730000	0.02906000	0.0026802	5.892	0.0008925	2.029	294.
0.82750000	0.02910000	0.0026845	5.899	0.0008948	2.030	294.
0.83620000	0.03074000	0.0028637	6.177	0.0009939	2.078	294.
0.83910000	0.03128000	0.0029233	6.268	0.0010276	2.092	294.
0.84190000	0.03232000	0.0030391	6.440	0.0010939	2.117	294.
0.84990000	0.03385000	0.0032116	6.692	0.0011950	2.150	294.
0.85150000	0.03414000	0.0032446	6.739	0.0012146	2.156	294.
0.86040000	0.03575000	0.0034294	6.998	0.0013262	2.183	294.
0.86240000	0.03615000	0.0034758	7.062	0.0013546	2.189	294.
0.87310000	0.03828000	0.0037257	7.398	0.0015106	2.216	294.
0.87360000	0.03839000	0.0037387	7.416	0.0015188	2.217	294.
0.88410000	0.04088000	0.0040341	7.804	0.0017064	2.241	295.
0.88510000	0.04113000	0.0040637	7.843	0.0017252	2.243	295.
0.89130000	0.04313000	0.0043010	8.155	0.0018760	2.262	295.
0.89590000	0.04475000	0.0044931	8.408	0.0019983	2.277	295.
0.90060000	0.04687000	0.[illegible]47446	8.739	0.0021585	2.297	295.
0.90710000	0.05121000	0.0052594	9.416	0.0024671	2.336	295.
0.90920000	0.05283000	0.0054515	9.669	0.0026099	2.350	29[illegible]
0.91560000	0.05752000	0.0060078	10.401	0.002966[illegible]	2.390	29[illegible]
0.91700000	0.05855000	0.0061300	10.562	0.0030445	2.399	295.
0.92130000	0.06308000	0.0066673	11.268	0.0033896	2.435	296.
0.92690000	0.07547000	0.0081370	13.202	0.0043380	2.529	296.
0.93150000	0.08496000	0.0092626	14.683	0.0050686	2.594	297.
0.93260000	0.08800000	0.0096232	15.157	0.0053034	2.613	297.
0.94070000	0.11435000	0.0127487	19.269	0.0073544	2.754	298.
0.94760000	0.13503000	0.0152017	22.496	0.0089836	2.831	299.
0.95060000	0.15920000	0.0180686	26.268	0.0109090	2.883	301.
0.95070000	0.16001000	0.0181647	26.394	0.0109739	2.884	301.
0.95840000	0.19406000	0.0222035	31.708	0.0137258	2.887	302.
0.96640000	0.31321000	0.0363365	50.301	0.0236911	2.275	309.
0.97160000	0.34013000	0.0395296	54.502	0.0260117	2.003	310.
0.97420000	0.34380000	0.0399649	55.075	0.0263299	1.962	310.
0.98010000	0.36594000	0.0425910	58.530	0.0282592	1.696	311.
0.98080000	0.36716000	0.0427357	58.720	0.0283660	1.681	311.

0.98570000	0.37616000	0.0438033	60.125	0.0[illegible]91551	1.562	312.
0.98670000	0.37735000	0.0439444	60.311	0.0292597	1.546	312.
0.98940000	0.38052000	0.0443204	60.805	0.0295384	1.503	312.
0.99600000	0.38351000	0.0446751	61.272	0.0298016	1.462	312.
0.99940000	0.38514000	0.0448684	61.526	0.0299452	1.439	312.
1.00000000	0.38518000	0.0448732	61.532	0.0299487	1.439	312.
1.00850000	0.38745000	0.0451424	61.887	0.0301488	1.406	312.
1.00880000	0.38754000	0.0451531	61.901	0.0301567	1.405	312.
1.01570000	0.38889000	0.0453132	62.111	0.0302758	1.386	312.
1.02130000	0.38989000	0.0454319	62.267	0.0303641	1.372	312.
1.02430000	0.39039000	0.0454912	62.345	0.0304082	1.364	312.
1.02760000	0.39060000	0.0455161	62.378	0.0304[illegible]	1.361	312.
1.03220000	0.39086000	0.0455469	62.419	0.0304497	1.358	312.
1.03420000	0.39170000	0.0456465	62.550	0.0305239	1.346	312.
1.04470000	0.39232000	0.0457201	62.647	0.0305787	1.337	312.
1.05130000	0.39287000	0.0457853	62.732	0.0306273	1.329	312.
1.05320000	0.39303000	0.0458043	62.757	0.0306414	1.326	312.
1.05880000	0.39332000	0.0458387	62.803	0.0306670	1.322	312.
1.06970000	0.39388000	0.0459051	62.890	0.0307165	1.314	312.
1.07630000	0.39426000	0.0459502	62.949	0.0307501	1.308	312.
1.08350000	0.39467000	0.0459988	63.013	0.0307864	1.302	312.
1.09400000	0.39524000	0.0460664	63.102	0.0308368	1.294	312.
1.09630000	0.39525000	0.0460676	63.104	0.0308377	1.294	312.
1.10460000	0.39530000	0.0460736	63.112	0.0308421	1.293	312.
1.11380000	0.39584000	0.0461376	63.196	0.0308899	1.285	313.
1.11570000	0.39595000	0.0461507	63.213	0.0308996	1.283	313.
1.12300000	0.39668000	0.0462372	63.327	0.0309642	1.273	313.

Be-172 kbar(shot# Be14)

in situ steady wave: sample thickness= 9.00mm
data entries=135

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.43130000	0.00000000	0.0000000	0.000	0.0000000	0.000	293.
0.45730000	0.00007000	0.0000053	0.017	0.0000000	0.008	293.
0.47250000	0.00007000	0.0000053	0.017	0.0000000	0.008	293.
0.48130000	0.00007000	0.0000053	0.017	0.0000000	0.008	293.
0.51590000	0.00007000	0.0000053	0.017	0.0000000	0.008	293.
0.52800000	0.00042000	0.0000321	0.102	0.0000001	0.048	293.
0.53410000	0.00049000	0.0000374	0.119	0.0000002	0.056	293.
0.53980000	0.00056000	0.0000428	0.136	0.0000002	0.064	293.
0.55280000	0.00063000	0.0000481	0.153	0.0000003	0.072	293.
0.56750000	0.00070000	0.0000535	0.170	0.0000004	0.080	293.
0.58410000	0.00091000	0.0000696	0.220	0.0000007	0.104	293.
0.58880000	0.00098000	0.0000750	0.237	0.0000008	0.111	293.
0.60200000	0.00118000	0.0000904	0.285	0.0000011	0.134	293.
0.61300000	0.00131000	0.0001004	0.316	0.0000013	0.148	293.
0.62240000	0.00150000	0.0001151	0.362	0.0000018	0.170	293.
0.63090000	0.00168000	0.0001290	0.405	0.0000022	0.190	293.
0.63700000	0.00186000	0.0001429	0.448	0.0000027	0.210	293.
0.63980000	0.00194000	0.0001492	0.467	0.0000030	0.218	293.
0.65120000	0.00220000	0.0001694	0.529	0.0000038	0.247	293.
0.65770000	0.00253000	0.0001951	0.607	0.0000050	0.283	293.
0.66500000	0.00293000	0.0002263	0.702	0.0000067	0.326	293.
0.67180000	0.00409000	0.0003177	0.975	0.0000130	0.450	293.
0.67230000	0.00417000	0.0003241	0.993	0.0000136	0.458	293.
0.67800000	0.00560000	0.0004382	1.325	0.0000244	0.606	293.
0.68400000	0.00609000	0.0004776	1.438	0.0000288	0.655	293.
0.68530000	0.00620000	0.0004865	1.463	0.0000298	0.666	293.
0.69220000	0.00685000	0.0005392	1.611	0.0000363	0.731	293.
0.69540000	0.00715000	0.0005636	1.680	0.0000396	0.761	293.
0.70400000	0.00804000	0.0006364	1.881	0.0000499	0.847	293.
0.70520000	0.00817000	0.0006471	1.910	0.0000515	0.859	293.
0.71820000	0.00986000	0.0007871	2.288	0.0000747	1.018	293.
0.72910000	0.01032000	0.0008256	2.390	0.0000817	1.060	293.
0.73010000	0.01038000	0.0008307	2.403	0.0000827	1.066	293.
0.73800000	0.01087000	0.0008719	2.511	0.0000906	1.110	293.
0.74020000	0.01109000	0.0008904	2.559	0.0000942	1.130	293.
0.74660000	0.01171000	0.0009429	2.695	0.0001049	1.185	293.
0.74960000	0.01239000	0.0010008	2.842	0.0001172	1.244	293.
0.75180000	0.01290000	0.0010444	2.953	0.0001269	1.288	293.
0.75870000	0.01393000	0.0011332	3.174	0.0001476	1.375	293.
0.76180000	0.01415000	0.0011522	3.221	0.0001522	1.393	293.
0.76810000	0.01459000	0.0011904	3.315	0.0001617	1.429	293.
0.77080000	0.01478000	0.0012070	3.355	0.0001659	1.445	293.
0.77940000	0.01539000	0.0012603	3.484	0.0001796	1.494	293.
0.77970000	0.01543000	0.0012638	3.493	0.0001805	1.498	293.
0.78710000	0.01624000	0.0013350	3.663	0.0001995	1.562	293.
0.78910000	0.01644000	0.0013527	3.705	0.0002044	1.578	293.
0.79690000	0.01723000	0.0014228	3.870	0.000224.	1.639	293.
0.79890000	0.01744000	0.0014415	3.914	0.0002295	1.655	293.
0.80620000	0.01819000	0.0015085	4.069	0.0002492	1.711	294.
0.80790000	0.01835000	0.0015229	4.102	0.0002535	1.723	294.
0.81310000	0.01892000	0.0015742	4.219	0.0002692	1.765	294.
0.81890000	0.01953000	0.0016294	4.344	0.0002864	1.810	294.
0.82360000	0.02004000	0.0016758	4.448	0.0003012	1.846	294.
0.82940000	0.02066000	0.0017324	4.573	0.0003197	1.890	294.
0.83740000	0.02136000	0.0017966	4.715	0.0003412	1.938	294.
0.84040000	0.02162000	0.0018206	4.767	0.0003494	1.956	294.
0.84840000	0.02261000	0.0019123	4.965	0.0003813	2.022	294.
0.84980000	0.02278000	0.0019281	4.998	0.0003869	2.033	294.
0.85840000	0.02359000	0.0020038	5.159	0.0004141	2.086	294.
0.85950000	0.02369000	0.0020132	5.179	0.0004176	2.092	294.
0.86570000	0.02436000	0.0020762	5.311	0.0004409	2.135	294.
0.87210000	0.02496000	0.0021329	5.428	0.0004623	2.172	294.
0.87370000	0.02511000	0.0021471	5.457	0.0004677	2.181	294.
0.88000000	0.02643000	0.0022730	5.714	0.0005167	2.261	294.
0.88330000	0.02690000	0.0023181	5.804	0.0005347	2.288	294.
0.88960000	0.02776000	0.0024011	5.969	0.0005684	2.337	294.
0.89630000	0.02932000	0.0025531	6.266	0.0006321	2.423	294.
0.89730000	0.02947000	0.0025678	6.294	0.0006384	2.431	294.
0.90420000	0.03051000	0.0026702	6.489	0.0006828	2.486	294.
0.90570000	0.03079000	0.0026979	6.542	0.0006950	2.500	294.
0.91010000	0.03161000	0.0027794	6.694	0.00073[illegible]	2.541	294.

0.91290000	0.03240000	0.0026584	6.841	0.0007671	2.580	294.
0.91510000	0.03301000	0.0029197	6.953	0.0007952	2.609	294.
0.91900000	0.03405000	0.0030249	7.143	0.0008444	2.657	294.
0.92060000	0.03447000	0.0030676	7.220	0.0008646	2.676	294.
0.92600000	0.03620000	0.0032449	7.532	0.0009504	2.750	294.
0.92660000	0.03655000	0.0032810	7.595	0.0009682	2.764	294.
0.92930000	0.03810000	0.0034421	7.871	0.0010490	2.826	294.
0.93300000	0.03966000	0.0036061	8.146	0.0011333	2.884	294.
0.93390000	0.04003000	0.0036452	8.211	0.0011537	2.897	294.
0.93780000	0.04177000	0.0038308	8.513	0.0012522	2.955	294.
0.93940000	0.04250000	0.0039093	8.638	0.0012946	2.979	294.
0.94060000	0.04313000	0.0039773	8.746	0.0013317	2.998	294.
0.94380000	0.04488000	0.0041679	9.044	0.0014374	3.048	295.
0.94440000	0.04522000	0.0042052	9.101	0.0014583	3.057	295.
0.94700000	0.04689000	0.0043882	9.383	0.0015611	3.103	295.
0.94940000	0.04853000	0.0045679	9.660	0.0016621	3.147	295.
0.95020000	0.04970000	0.0046961	9.858	0.0017342	3.179	295.
0.95110000	0.05110000	0.0048495	10.094	0.0018206	3.216	295.
0.95280000	0.05370000	0.0051344	10.534	0.0019812	3.286	295.
0.95340000	0.05457000	0.0052297	10.680	0.0020350	3.309	295.
0.95530000	0.05632000	0.0054215	10.976	0.0021433	3.356	295.
0.95780000	0.05851000	0.0056615	11.346	0.0022790	3.414	295.
0.95820000	0.05916000	0.0057327	11.456	0.0023193	3.431	295.
0.96180000	0.06478000	0.0063485	12.405	0.0026685	3.578	296.
0.96360000	0.06738000	0.0066334	12.844	0.0028304	3.645	296.
0.96530000	0.06986000	0.0069051	13.263	0.0029852	3.709	296.
0.96620000	0.07119000	0.0070509	13.488	0.0030682	3.743	296.
0.96830000	0.07884000	0.0078891	14.780	0.0035474	3.937	296.
0.96910000	0.08226000	0.0082639	15.358	0.0037623	4.023	296.
0.96950000	0.08448000	0.0085071	15.733	0.0039021	4.078	296.
0.97080000	0.09037000	0.0091525	16.728	0.0042738	4.223	297.
0.97110000	0.09088000	0.0092084	16.814	0.0043060	4.236	297.
0.97230000	0.09288000	0.0094276	17.152	0.0044326	4.284	297.
0.97240000	0.09304000	0.0094451	17.179	0.0044427	4.288	297.
0.97350000	0.10709000	0.0109846	19.552	0.0053361	4.623	298.
0.97410000	0.11545000	0.0119007	20.965	0.0058712	4.817	298.
0.97550000	0.12860000	0.0133416	23.186	0.0067183	5.113	299.
0.97580000	0.13444000	0.0139815	24.172	0.0070965	5.240	299.
0.97590000	0.13642000	0.0141985	24.507	0.0072251	5.283	299.
0.98290000	0.93764000	0.1019929	159.852	0.0695112	3.787	345.
0.98390000	0.97690000	0.1062948	166.484	0.0729998	2.747	347.
0.98500000	0.98288000	0.1069501	167.494	0.0735338	2.581	347.
0.98550000	0.98589000	0.1072799	168.002	0.0738029	2.497	347.
0.98910000	0.99021000	0.1077533	168.732	0.0741894	2.375	348.
0.98960000	0.99094000	0.1078333	168.855	0.0742547	2.354	348.
0.99130000	0.99423000	0.1081938	169.411	0.0745493	2.261	348.
0.99230000	0.99719000	0.1085181	169.911	0.0748146	2.176	348.
0.99250000	0.99776000	0.1085806	170.008	0.0748657	2.160	348.
0.99390000	0.99990000	0.1088151	170.369	0.0750575	2.098	348.
0.99460000	1.00094000	0.1089290	170.545	0.0751508	2.068	348.
0.99550000	1.00168000	0.1090101	170.670	0.0752172	2.047	348.
0.99710000	1.00299000	0.1091537	170.891	0.0753348	2.009	348.
0.99990000	1.00445000	0.1093137	171.138	0.0754658	1.966	348.
1.00130000	1.00518000	0.1093936	171.261	0.0755314	1.945	348.
1.00510000	1.00752000	0.1096500	171.656	0.0757415	1.877	348.
1.03310000	1.00770000	0.1096698	171.687	0.0757577	1.871	348.
1.03480000	1.00794000	0.1096961	171.727	0.0757792	1.864	348.
1.04150000	1.00889000	0.1098002	171.888	0.0758646	1.836	348.
1.05110000	1.00992000	0.1099130	172.062	0.0759571	1.806	348.
1.05780000	1.01019000	0.1099426	172.107	0.0759814	1.798	348.
1.06670000	1.01031000	0.1099558	172.128	0.0759922	1.795	348.
1.07590000	1.01041000	0.1099667	172.144	0.0760012	1.792	349.
1.08430000	1.01149000	0.1100851	172.327	0.0760983	1.760	349.
1.09270000	1.01158000	0.1100949	172.342	0.0761064	1.757	349.

Bi-11 kbar(shot# 147)

in situ steady wave: sample thickness= 4.06mm
data entries= 51

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.42290300	0.00021920	0.0000981	0.048	0.0000000	0.012	294.
0.42409950	0.00028400	0.0001271	0.062	0.0000000	0.016	294.
0.42474290	0.00057890	0.0002590	0.127	0.0000000	0.032	294.
0.42639360	0.00133360	0.0005958	0.292	0.0000000	0.073	294.
0.42917060	0.00331170	0.0014744	0.727	0.0000000	0.184	294.
0.43085580	0.00408820	0.0018176	0.899	0.0000000	0.227	294.
0.43327540	0.00523150	0.0023212	1.153	0.0000000	0.293	294.
0.43762170	0.00720650	0.0032114	1.581	0.0000934	0.392	295.
0.43840690	0.00751430	0.0033540	1.646	0.0001243	0.405	295.
0.44521800	0.01003790	0.0045634	2.161	0.0005329	0.487	295.
0.44909820	0.01140600	0.0052488	2.428	0.0008652	0.514	295.
0.45304100	0.01271250	0.0059228	2.676	0.0012519	0.529	296.
0.46115810	0.01542070	0.0073396	3.182	0.0021310	0.547	296.
0.46178070	0.01560350	0.0074352	3.216	0.0021910	0.548	296.
0.46935910	0.01791390	0.0086440	3.648	0.0029560	0.561	297.
0.47145120	0.01859420	0.0089999	3.775	0.0031836	0.564	297.
0.47443190	0.01958500	0.0095182	3.960	0.0035170	0.569	297.
0.48039660	0.02179740	0.0106757	4.374	0.0042698	0.577	297.
0.48274380	0.02280710	0.0112039	4.562	0.0046170	0.580	297.
0.48671640	0.02485370	0.0122746	4.945	0.0053279	0.585	298.
0.48676840	0.02488150	0.0122892	4.950	0.0053376	0.585	298.
0.49050600	0.02665830	0.0132187	5.282	0.0059623	0.588	298.
0.49391520	0.02896820	0.0144272	5.714	0.0067849	0.590	299.
0.49443200	0.02928590	0.0145934	5.773	0.0068989	0.590	299.
0.49788070	0.03210550	0.0160685	6.300	0.0079204	0.588	299.
0.49884890	0.03284270	0.0164542	6.438	0.0081903	0.588	299.
0.50197020	0.03634140	0.0182846	7.092	0.0094865	0.580	300.
0.50203900	0.03641720	0.0183243	7.106	0.0095118	0.580	300.
0.50578100	0.04029490	0.0203529	7.831	0.0109816	0.565	301.
0.50661740	0.04112270	0.0207860	7.985	0.0112987	0.561	301.
0.50903210	0.04366570	0.0221161	8.461	0.0122814	0.547	301.
0.51114070	0.04566190	0.0231608	8.8[illegible]4	0.0130619	0.534	301.
0.51154740	0.04595610	0.0233147	8.889	0.0131776	0.531	302.
0.51412390	0.04779220	0.0242753	9.232	0.0139035	0.518	302.
0.51492040	0.04835560	0.0245700	9.337	0.0141276	0.513	302.
0.51737510	0.04977020	0.0253101	9.601	0.0146930	0.501	302.
0.51783270	0.05003610	0.0254492	9.651	0.0147997	0.499	302.
0.52062650	0.05111480	0.0260136	9.853	0.0152340	0.489	302.
0.52161220	0.05150160	0.0262159	9.925	0.0153903	0.486	303.
0.52508230	0.05264880	0.0268161	10.139	0.0158556	0.474	303.
0.52700610	0.05305660	0.0270294	10.216	0.0160216	0.470	303.
0.52861400	0.05340260	0.0272105	10.280	0.0161627	0.467	303.
0.53301340	0.05423780	0.0276474	10.436	0.0165043	0.458	303.
0.53424490	0.05441570	0.0277405	10.470	0.0165772	0.456	303.
0.53741260	0.05488140	0.0279841	10.557	0.0167684	0.451	303.
0.54266420	0.05574340	0.0284351	10.718	0.0171234	0.441	303.
0.54919950	0.05637720	0.0287667	10.836	0.0173854	0.434	303.
0.55303860	0.05649260	0.0288270	10.858	0.0174332	0.433	303.
0.55665920	0.05660280	0.0288847	10.878	0.0174788	0.432	303.
0.56183810	0.05750420	0.0293563	11.047	0.0178531	0.421	304.
0.58434110	0.05800300	0.0296172	11.140	0.0180609	0.415	304.

Bi-23 kbar(shot# 149)

in situ steady wave: sample thickness= 3.04mm
data entries= 44

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.42450320	0.00014730	0.0000659	0.032	0.0000000	0.008	294.
0.42538740	0.00039700	0.0001777	0.087	0.0000000	0.022	294.
0.42731820	0.00073610	0.0003292	0.161	0.0000000	0.040	294.
0.43332780	0.00212240	0.0009469	0.465	0.0000000	0.117	294.
0.43410750	0.00232820	0.0010383	0.510	0.0000000	0.128	294.
0.43856110	0.00349000	0.0015532	0.767	0.0000000	0.194	294.
0.43940650	0.00384540	0.0017104	0.845	0.0000000	0.214	294.
0.44346690	0.00554490	0.0024590	1.223	0.0000000	0.311	295.
0.44561630	0.00658430	0.0029205	1.451	0.0000224	0.367	295.
0.44935430	0.00843620	0.0037678	1.847	0.0001691	0.452	295.
0.44967310	0.00860430	0.0038463	1.882	0.0001890	0.459	295.
0.45414410	0.01103010	0.0050083	2.378	0.0005901	0.537	295.
0.45581350	0.01211050	0.0055435	2.591	0.0008356	0.561	296.
0.45844970	0.01373640	0.0063571	2.909	0.0012386	0.593	296.
0.46227320	0.01618780	0.0075837	3.388	0.0018596	0.638	296.
0.46300320	0.01665070	0.0078153	3.478	0.0019787	0.646	296.
0.46747420	0.02088800	0.0099356	4.306	0.0030938	0.717	297.
0.46897800	0.02230800	0.0106462	4.58[illegible]	0.0034775	0.740	297.
0.47213050	0.02570860	0.0123478	5.248	0.0044160	0.790	298.
0.47224030	0.02584430	0.0124157	5.274	0.0044540	0.792	298.
0.47462180	0.03005130	0.0145208	6.096	0.0056532	0.847	299.
0.47616730	0.03454100	0.0167674	6.974	0.0069760	0.898	299.
0.47695260	0.03642900	0.0177122	7.342	0.0075451	0.917	300.
0.47797380	0.04120250	0.0201008	8.275	0.0090166	0.960	301.
0.48024750	0.05659860	0.0278048	11.283	0.0140635	1.034	303.
0.48113170	0.06526290	0.0321403	12.976	0.0170931	1.035	305.
0.48142980	0.06845100	0.0337356	13.599	0.0182406	1.028	305.
0.48346220	0.08560460	0.0423191	16.951	0.0247042	0.921	308.
0.48482860	0.09193450	0.0454865	18.188	0.0272101	0.852	309.
0.48567100	0.09661790	0.0478300	19.103	0.0291052	0.792	310.
0.48677050	0.10095020	0.0499978	19.949	0.0308894	0.728	311.
0.48707880	0.10152150	0.0502837	20.061	0.0311268	0.719	311.
0.48957000	0.10429510	0.0516716	20.603	0.0322872	0.673	312.
0.49203300	0.10645480	0.0527523	21.025	0.0331992	0.636	312.
0.49230250	0.10667950	0.0528647	21.069	0.0332945	0.632	312.
0.49431190	0.10849180	0.0537716	21.423	0.0340662	0.599	312.
0.49698090	0.10989860	0.0544755	21.698	0.0346688	0.572	313.
0.49712460	0.10997380	0.0545131	21.712	0.0347011	0.571	313.
0.49993760	0.11084590	0.0549495	21.883	0.0350764	0.554	313.
0.50419690	0.11249050	0.0557725	22.204	0.0357873	0.521	313.
0.50452100	0.11253090	0.0557927	22.212	0.0358048	0.520	313.
0.51496740	0.11444940	0.0567527	22.587	0.0366398	0.481	313.
0.53546680	0.11660460	0.0578311	23.008	0.0375848	0.435	314.
0.54959950	0.11707260	0.0580653	23.099	0.0377910	0.425	314.

Cu-32 kbar(shot# H800)

in situ steady wave: sample thickness= 9.97mm
data entries=100

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.25629800	0.00039207	0.0000841	0.163	0.0000020	0.036	300.
0.33570371	0.00111581	0.0002417	0.460	0.0000165	0.096	300.
0.40960951	0.00185740	0.0004065	0.759	0.0000458	0.150	300.
0.46715360	0.00257577	0.0005693	1.042	0.0000878	0.194	300.
0.50280303	0.00336466	0.0007516	1.347	0.0001492	0.234	300.
0.52661794	0.00400739	0.0009029	1.591	0.0002107	0.261	301.
0.54365248	0.00464234	0.0010549	1.828	0.0002815	0.281	301.
0.55660502	0.00528464	0.0012110	2.064	0.0003632	0.296	301.
0.56692514	0.00593477	0.0013712	2.300	0.0004548	0.307	301.
0.57490404	0.00662608	0.0015420	2.550	0.0005537	0.317	301.
0.58118555	0.00735377	0.0017217	2.813	0.0006582	0.328	301.
0.58627247	0.00810710	0.0019077	3.086	0.0007668	0.338	301.
0.59048385	0.00887887	0.0020983	3.365	0.0008784	0.349	301.
0.59403302	0.00966332	0.0022920	3.649	0.0009923	0.360	301.
0.59706849	0.01045591	0.0024877	3.936	0.0011078	0.370	302.
0.59969714	0.01125327	0.0026846	4.225	0.0012243	0.380	302.
0.60199799	0.01205421	0.0028824	4.514	0.0013419	0.391	302.
0.60403076	0.01285890	0.0030812	4.806	0.0014603	0.401	302.
0.60584153	0.01366841	0.0032811	5.099	0.0015800	0.410	302.
0.60746640	0.01448407	0.0034825	5.394	0.0017010	0.420	302.
0.60893408	0.01530700	0.0036857	5.692	0.0018235	0.429	302.
0.61026771	0.01613792	0.0038909	5.992	0.0019476	0.438	302.
0.61148615	0.01697720	0.0040982	6.296	0.0020735	0.447	302.
0.61260492	0.01782488	0.0043075	6.603	0.0022010	0.456	303.
0.61363693	0.01868077	0.0045189	6.912	0.0023303	0.465	303.
0.61459297	0.01954451	0.0047322	7.225	0.0024612	0.473	303.
0.61548219	0.02041559	0.0049473	7.540	0.0025938	0.481	303.
0.61631233	0.02129340	0.0051641	7.858	0.0027279	0.489	303.
0.61709005	0.02217728	0.0053823	8.178	0.0028633	0.497	303.
0.61782108	0.02306654	0.0056019	8.500	0.0030002	0.504	303.
0.61851036	0.02396048	0.0058227	8.823	0.0031382	0.511	304.
0.61916222	0.02485842	0.0060444	9.148	0.0032774	0.518	304.
0.61978044	0.02575972	0.0062670	9.474	0.0034176	0.525	304.
0.62036834	0.02666375	0.0064903	9.801	0.0035588	0.531	304.
0.62092886	0.02756997	0.0067141	10.129	0.0037008	0.537	304.
0.62146461	0.02847787	0.0069383	10.458	0.0038436	0.543	304.
0.62197791	0.02938701	0.0071628	10.787	0.0039871	0.548	304.
0.62247085	0.03029701	0.0073875	11.116	0.0041313	0.553	305.
0.62294528	0.03120758	0.0076124	11.446	0.0042761	0.558	305.
0.62340291	0.03211846	0.0078373	11.775	0.0044214	0.562	305.
0.62384527	0.03302951	0.0080623	12.105	0.0045673	0.566	305.
0.62427374	0.03394059	0.0082873	12.435	0.0047137	0.570	305.
0.62468960	0.03485164	0.0085123	12.764	0.0048606	0.573	305.
0.62509402	0.03576265	0.0087373	13.094	0.0050080	0.576	305.
0.62548809	0.03667362	0.0089622	13.424	0.0051560	0.579	306.
0.62587279	0.03758457	0.0091872	13.753	0.0053044	0.581	306.
0.62624906	0.03849553	0.0094121	14.083	0.0054533	0.583	306.
0.62661776	0.03940654	0.0096371	14.413	0.0056028	0.585	306.
0.62697973	0.04031761	0.0098621	14.742	0.0057527	0.587	306.
0.62733573	0.04122878	0.0100871	15.072	0.0059032	0.588	306.
0.62768649	0.04214003	0.0103122	15.402	0.0060542	0.589	306.
0.62803273	0.04305136	0.0105372	15.732	0.0062057	0.589	307.
0.62837512	0.04396275	0.0107623	16.061	0.0063578	0.589	307.
0.62871432	0.04487417	0.0109874	16.391	0.0065103	0.589	307.
0.62905098	0.04578558	0.0112124	16.721	0.0066633	0.589	307.
0.62938572	0.04669697	0.0114375	17.051	0.0068168	0.588	307.
0.62971917	0.04760829	0.0116625	17.381	0.0069708	0.587	307.
0.63005197	0.04851954	0.0118876	17.710	0.0071253	0.585	307.
0.63038475	0.04943071	0.0121126	18.040	0.0072802	0.583	307.
0.63071813	0.05034183	0.0123376	18.370	0.0074357	0.581	308.
0.63105279	0.05125296	0.0125626	18.699	0.0075916	0.579	308.
0.63138940	0.05216419	0.0127876	19.029	0.0077480	0.576	308.
0.63172867	0.05307567	0.0130127	19.359	0.0079050	0.573	308.
0.63207133	0.05398755	0.0132379	19.689	0.0080625	0.570	308.
0.63241817	0.05490009	0.0134633	20.019	0.0082206	0.566	308.
0.63277002	0.05581355	0.0136888	20.350	0.0083793	0.562	308.
0.63312778	0.05672827	0.0139147	20.681	0.0085387	0.558	309.
0.63349241	0.05764463	0.0141410	21.012	0.0086990	0.553	309.
0.63386497	0.05856308	0.0143678	21.345	0.0088600	0.548	309.
0.63424662	0.05948410	0.0145953	21.678	0.0090220	0.543	309.
0.63463864	0.06040822	0.0148235	22.013	0.0091850	0.537	309.

0.63504246	0.06133607	0.0150526	22.348	0.0093492	0.531	309.
0.63545967	0.06226832	0.0152829	22.686	0.0095146	0.524	309.
0.63589209	0.06320577	0.0155144	23.025	0.0096815	0.518	310.
0.63634175	0.06414935	0.0157474	23.366	0.0098499	0.510	310.
0.63681103	0.06510025	0.0159822	23.710	0.0100202	0.503	310.
0.63730262	0.06605999	0.0162192	24.058	0.0101925	0.495	310.
0.63781971	0.06703074	0.0164589	24.409	0.0103674	0.486	310.
0.63836598	0.06801563	0.0167022	24.765	0.0105453	0.477	310.
0.63894582	0.06901960	0.0169501	25.129	0.0107273	0.468	311.
0.63956448	0.07005070	0.0172047	25.502	0.0109147	0.458	311.
0.64022826	0.07111913	0.0174686	25.889	0.0111095	0.447	311.
0.64094488	0.07222168	0.0177408	26.288	0.0113112	0.435	311.
0.64172384	0.07333754	0.0180164	26.691	0.0115160	0.423	311.
0.64257702	0.07441156	0.0182816	27.080	0.0117138	0.410	311.
0.64351951	0.07539237	0.0185238	27.435	0.0118950	0.399	312.
0.64457074	0.07626306	0.0187389	27.750	0.0120562	0.388	312.
0.64575627	0.07704732	0.0189325	28.034	0.0122018	0.378	312.
0.64711039	0.07779388	0.0191169	28.304	0.0123407	0.368	312.
0.64868032	0.07855270	0.0193043	28.579	0.0124822	0.358	312.
0.65053295	0.07935139	0.0195015	28.868	0.0126315	0.348	312.
0.65276647	0.08017693	0.0197054	29.166	0.0127861	0.336	312.
0.65553125	0.08099868	0.0199083	29.464	0.0129404	0.325	312.
0.65907024	0.08182301	0.0201119	29.762	0.0130955	0.313	313.
0.66380377	0.08267175	0.0203215	30.069	0.0132556	0.300	313.
0.67052872	0.08354708	0.0205377	30.386	0.0134211	0.287	313.
0.68096457	0.08444507	0.0207594	30.711	0.0135913	0.273	313.
0.69963722	0.08533934	0.0209803	31.035	0.0137612	0.259	313.
0.74353440	0.08618917	0.0211901	31.342	0.0139231	0.246	313.
0.97567609	0.08709720	0.0214144	31.671	0.0140965	0.231	313.

Cu-30 kbar(shot #H801)

in situ steady wave: sample thickness=19.94mm
data entries=100

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.34703989	0.00049311	0.0001058	0.205	0.0000025	0.045	300.
0.41576267	0.00126197	0.0002735	0.520	0.0000190	0.109	300.
0.49188142	0.00217593	0.0004773	0.887	0.0000585	0.173	300.
0.57483072	0.00312329	0.0006938	1.257	0.0001217	0.227	300.
0.65620726	0.00394038	0.0008847	1.570	0.0001940	0.264	301.
0.70957121	0.00464989	0.0010537	1.836	0.0002700	0.288	301.
0.74544163	0.00521006	0.0011892	2.043	0.0003385	0.303	301.
0.77145397	0.00572057	0.0013142	2.229	0.0004074	0.313	301.
0.79089410	0.00625365	0.0014458	2.422	0.0004832	0.321	301.
0.80516934	0.00688132	0.0016007	2.650	0.0005728	0.331	301.
0.81607110	0.00758016	0.0017731	2.903	0.0006728	0.341	301.
0.82465629	0.00832261	0.0019563	3.172	0.0007794	0.352	301.
0.83158273	0.00908961	0.0021456	3.449	0.0008899	0.363	301.
0.83728180	0.00986919	0.0023380	3.732	0.0010026	0.373	301.
0.84204834	0.01065350	0.0025315	4.016	0.0011164	0.384	302.
0.84609072	0.01143790	0.0027251	4.300	0.0012307	0.394	302.
0.84956029	0.01222055	0.0029182	4.583	0.0013450	0.405	302.
0.85256961	0.01300314	0.0031113	4.867	0.0014598	0.414	302.
0.85520407	0.01378856	0.0033052	5.151	0.0015754	0.424	302.
0.85752956	0.01457964	0.0035004	5.437	0.0016923	0.434	302.
0.85959772	0.01537873	0.0036976	5.727	0.0018107	0.443	302.
0.86144954	0.01618774	0.0038972	6.020	0.0019311	0.452	302.
0.86311799	0.01700824	0.0040997	6.317	0.0020536	0.461	302.
0.86462981	0.01784141	0.0043053	6.619	0.0021784	0.470	303.
0.86600698	0.01868790	0.0045142	6.925	0.0023057	0.479	303.
0.86726765	0.01954783	0.0047264	7.237	0.0024354	0.488	303.
0.86842697	0.02042071	0.0049418	7.553	0.0025677	0.496	303.
0.86949769	0.02130560	0.0051602	7.873	0.0027022	0.505	303.
0.87049059	0.02220117	0.0053812	8.197	0.0028389	0.513	303.
0.87141483	0.02310586	0.0056044	8.525	0.0029775	0.521	303.
0.87227830	0.02401799	0.0058295	8.855	0.0031178	0.528	304.
0.87308776	0.02493590	0.0060560	9.188	0.0032594	0.536	304.
0.87384910	0.02585798	0.0062836	9.522	0.0034023	0.543	304.
0.87456742	0.02678275	0.0065118	9.857	0.0035461	0.549	304.
0.87524721	0.02770891	0.0067403	10.192	0.0036907	0.556	304.
0.87589239	0.02863530	0.0069689	10.528	0.0038359	0.562	304.
0.87650645	0.02956101	0.0071974	10.863	0.0039815	0.567	304.
0.87709246	0.03048529	0.0074254	11.197	0.0041274	0.573	305.
0.87765317	0.03140765	0.0076530	11.532	0.0042735	0.578	305.
0.87819105	0.03232776	0.0078801	11.865	0.0044198	0.583	305.
0.87870830	0.03324552	0.0081066	12.197	0.0045663	0.587	305.
0.87920691	0.03416100	0.0083325	12.529	0.0047129	0.591	305.
0.87968870	0.03507438	0.0085579	12.859	0.0048597	0.595	305.
0.88015531	0.03598597	0.0087828	13.189	0.0050067	0.598	305.
0.88060826	0.03689611	0.0090074	13.519	0.0051540	0.601	306.
0.88104893	0.03780519	0.0092318	13.848	0.0053017	0.604	306.
0.88147860	0.03871359	0.0094559	14.177	0.0054497	0.606	306.
0.88189846	0.03962169	0.0096800	14.506	0.0055982	0.608	306.
0.88230964	0.04052981	0.0099041	14.835	0.0057472	0.610	306.
0.88271317	0.04143825	0.0101283	15.164	0.0058967	0.611	306.
0.88311006	0.04234724	0.0103526	15.493	0.0060468	0.612	306.
0.88350125	0.04325695	0.0105771	15.823	0.0061976	0.613	307.
0.88388764	0.04416748	0.0108018	16.152	0.0063489	0.614	307.
0.88427011	0.04507887	0.0110267	16.482	0.0065010	0.614	307.
0.88464953	0.04599104	0.0112518	16.813	0.0066536	0.614	307.
0.88502673	0.04690390	0.0114771	17.143	0.0068069	0.613	307.
0.88540254	0.04781726	0.0117025	17.474	0.0069607	0.612	307.
0.88577780	0.04873093	0.0119279	17.805	0.0071151	0.611	307.
0.88615335	0.04964472	0.0121534	18.136	0.0072700	0.610	308.
0.88653004	0.05055848	0.0123789	18.467	0.0074254	0.608	308.
0.88690876	0.05147214	0.0126044	18.798	0.0075812	0.606	308.
0.88729042	0.05238575	0.0128298	19.129	0.0077376	0.603	308.
0.88767598	0.05329952	0.0130553	19.459	0.0078944	0.600	308.
0.88806643	0.05421382	0.0132810	19.791	0.0080518	0.597	308.
0.88846285	0.05512924	0.0135069	20.122	0.0082100	0.594	308.
0.88886639	0.05604654	0.0137332	20.454	0.0083689	0.590	309.
0.88927829	0.05696665	0.0139603	20.787	0.0085288	0.586	309.
0.88969992	0.05789069	0.0141883	21.122	0.0086898	0.582	309.
0.89013277	0.05881987	0.0144176	21.459	0.0088523	0.577	309.
0.89057848	0.05975551	0.0146481	21.797	0.0090164	[illegible]	309.
0.89103891	0.06069894	0.0148813	22.134	0.0091823	0.566	309.

0.89151613	0.06165156	0.0151164	22.484	0.0093504	0.560	309.
0.89201248	0.06261477	0.0153541	22.833	0.0095209	0.554	310.
0.89253065	0.06359005	0.0155947	23.186	0.0096940	0.547	310.
0.89307371	0.06457904	0.0158388	23.544	0.0098701	0.540	310.
0.89364522	0.06558369	0.0160867	23.908	0.0100496	0.532	310.
0.89424936	0.06660651	0.0163391	24.278	0.0102329	0.524	310.
0.89489100	0.06765097	0.0165969	24.657	0.0104207	0.515	310.
0.89557596	0.06872200	0.0168612	25.045	0.0106139	0.505	310.
0.89631118	0.06982617	0.0171336	25.444	0.0108137	0.495	311.
0.89710505	0.07096868	0.0174156	25.858	0.0110212	0.484	311.
0.89796784	0.07214356	0.0177055	26.284	0.0112353	0.472	311.
0.89891221	0.07333283	0.0179990	26.714	0.0114528	0.459	311.
0.89995400	0.07447872	0.0182817	27.129	0.0116630	0.446	311.
0.90111327	0.07550307	0.0185345	27.500	0.0118516	0.434	312.
0.90241585	0.07638039	0.0187510	27.818	0.0120136	0.424	312.
0.90389552	0.07716895	0.0189456	28.103	0.0121595	0.414	312.
0.90559734	0.07795449	0.0191395	28.388	0.0123052	0.404	312.
0.90758276	0.07879073	0.0193458	28.691	0.0124607	0.394	312.
0.90993764	0.07968228	0.0195658	29.014	0.0126269	0.382	312.
0.91278565	0.08058448	0.0197885	29.340	0.0127954	0.370	312.
0.91631114	0.08146384	0.0200055	29.659	0.0129602	0.358	312.
0.92080085	0.08234678	0.0202234	29.979	0.0131260	0.345	313.
0.92672445	0.08324631	0.0204453	30.304	0.0132953	0.332	313.
0.93490337	0.08415907	0.0206706	30.635	0.0134676	0.319	313.
0.94690262	0.08508824	0.0208999	30.971	0.0136434	0.304	313.
0.96607377	0.08602327	0.0211306	31.310	0.0138208	0.290	313.
1.00092953	0.08692054	0.0213520	31.635	0.0139915	0.276	313.
1.07998992	0.08778634	0.0215657	31.948	0.0141565	0.261	313.
1.36999690	0.08903892	0.0218748	32.402	0.0143960	0.241	314.

Cu-33 kbar(shot# H802)

In situ steady wave: sample thickness=29.96mm
data entries=100

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.08729347	0.00038149	0.0000818	0.159	0.0000019	0.035	300.
0.27001243	0.00109627	0.0002373	0.453	0.0000155	0.095	300.
0.41785583	0.00193298	0.0004231	0.789	0.0000479	0.156	300.
0.54786073	0.00272048	0.0006016	1.100	0.0000944	0.204	300.
0.63781054	0.00350636	0.0007834	1.404	0.0001559	0.244	300.
0.69676075	0.00418651	0.0009435	1.662	0.0002211	0.272	301.
0.73829082	0.00484241	0.0011004	1.907	0.0002944	0.293	301.
0.76947186	0.00548942	0.0012576	2.145	0.0003765	0.308	301.
0.79057934	0.00613322	0.0014162	2.378	0.0004667	0.319	301.
0.80375519	0.00681929	0.0015854	2.627	0.0005644	0.329	301.
0.81404319	0.00754704	0.0017650	2.890	0.0006683	0.340	301.
0.82231404	0.00830423	0.0019518	3.165	0.0007768	0.351	301.
0.82911640	0.00908150	0.0021435	3.446	0.0008886	0.362	301.
0.83481476	0.00987212	0.0023386	3.733	0.0010027	0.374	301.
0.83966147	0.01067150	0.0025358	4.022	0.0011185	0.385	302.
0.84383713	0.01147651	0.0027344	4.314	0.0012355	0.395	302.
0.84747463	0.01228630	0.0029341	4.607	0.0013537	0.406	302.
0.85067396	0.01310099	0.0031351	4.902	0.0014730	0.416	302.
0.85351190	0.01392131	0.0033375	5.199	0.0015935	0.427	302.
0.85604937	0.01474818	0.0035415	5.499	0.0017155	0.437	302.
0.85833086	0.01558237	0.0037473	5.801	0.0018391	0.446	302.
0.86039748	0.01642444	0.0039550	6.106	0.0019642	0.456	302.
0.86227918	0.01727475	0.0041648	6.414	0.0020911	0.466	303.
0.86400134	0.01813345	0.0043766	6.725	0.0022196	0.475	303.
0.86558500	0.01900054	0.0045905	7.039	0.0023499	0.484	303.
0.86704773	0.01987583	0.0048065	7.356	0.0024820	0.493	303.
0.86840432	0.02075903	0.0050244	7.676	0.0026157	0.501	303.
0.86966732	0.02164969	0.0052441	7.999	0.0027511	0.510	303.
0.87084741	0.02254731	0.0054655	8.324	0.0028880	0.518	303.
0.87195381	0.02345129	0.0056885	8.652	0.0030265	0.526	303.
0.87299445	0.02436100	0.0059130	8.981	0.0031663	0.533	304.
0.87397623	0.02527581	0.0061387	9.313	0.0033075	0.541	304.
0.87490517	0.02619506	0.0063654	9.646	0.0034499	0.548	304.
0.87578656	0.02711816	0.0065932	9.980	0.0035934	0.554	304.
0.87662505	0.02804451	0.0068217	10.315	0.0037380	0.561	304.
0.87742477	0.02897358	0.0070509	10.652	0.0038835	0.567	304.
0.87818937	0.02990491	0.0072807	10.989	0.0040299	0.573	304.
0.87892214	0.03083807	0.0075109	11.327	0.0041772	0.578	305.
0.87962600	0.03177272	0.0077415	11.666	0.0043252	0.583	305.
0.88030360	0.03270856	0.0079723	12.005	0.0044740	0.588	305.
0.88095733	0.03364537	0.0082034	12.344	0.0046235	0.593	305.
0.88158934	0.03458296	0.0084347	12.684	0.0047736	0.597	305.
0.88220162	0.03552121	0.0086662	13.024	0.0049244	0.600	305.
0.88279597	0.03646000	0.0088978	13.364	0.0050758	0.604	305.
0.88337405	0.03739930	0.0091295	13.704	0.0052279	0.607	306.
0.88393739	0.03833903	0.0093614	14.045	0.0053805	0.610	306.
0.88448743	0.03927919	0.0095933	14.385	0.0055338	0.612	306.
0.88502547	0.04021974	0.0098253	14.726	0.0056876	0.614	306.
0.88555276	0.04116068	0.0100575	15.067	0.0058421	0.616	306.
0.88607047	0.04210197	0.0102897	15.408	0.0059972	0.617	306.
0.88657970	0.04304361	0.0105220	15.749	0.0061528	0.618	306.
0.88708151	0.04398556	0.0107544	16.090	0.0063091	0.619	307.
0.88757690	0.04492778	0.0109868	16.431	0.0064659	0.619	307.
0.88806685	0.04587025	0.0112193	16.773	0.0066233	0.619	307.
0.88855230	0.04681292	0.0114519	17.114	0.0067812	0.619	307.
0.88903418	0.04775573	0.0116845	17.456	0.0069397	0.618	307.
0.88951339	0.04869864	0.0119171	17.797	0.0070988	0.617	307.
0.88999084	0.04964162	0.0121497	18.139	0.0072584	0.616	308.
0.89046744	0.05058463	0.0123824	18.480	0.0074185	0.614	308.
0.89094409	0.05152765	0.0126150	18.822	0.0075791	0.612	308.
0.89142171	0.05247068	0.0128477	19.164	0.0077403	0.610	308.
0.89190127	0.05341375	0.0130803	19.505	0.0079019	0.607	308.
0.89238374	0.05435693	0.0133130	19.847	0.0080642	0.604	308.
0.89287014	0.05530031	0.0135457	20.189	0.0082269	0.600	308.
0.89336156	0.05624403	0.0137785	20.531	0.0083903	0.597	309.
0.89385912	0.05718829	0.0140115	20.873	0.0085542	0.593	309.
0.89436404	0.05813334	0.0142446	21.215	0.0087188	0.588	309.
0.89487764	0.05907947	0.0144780	21.558	0.0088841	0.583	309.
0.89540131	0.06002706	0.0147118	21.901	0.0090502	0.578	309.
0.89593662	0.06097652	0.0149460	22.245	0.0092171	0.572	309.
0.89648526	0.06192935	0.0151809	22.590	0.0093859	0.567	309.

0.89704910	0.06288310	0.0154164	22.936	0.0095538	0.560	310.
0.89763026	0.06384140	0.0156528	23.283	0.0097239	0.554	310.
0.89823108	0.06480397	0.0158903	23.631	0.0098952	0.547	310.
0.89885424	0.06577166	0.0161290	23.982	0.0100679	0.539	310.
0.89950277	0.06674545	0.0163692	24.335	0.0102422	0.532	310.
0.90018017	0.06772658	0.0166113	24.690	0.0104184	0.523	310.
0.90089047	0.06871664	0.0168555	25.049	0.0105968	0.515	310.
0.90163838	0.06971781	0.0171025	25.411	0.0107777	0.505	311.
0.90242944	0.07073323	0.0173530	25.779	0.0109617	0.496	311.
0.90327023	0.07176778	0.0176083	26.154	0.0111498	0.485	311.
0.90416861	0.07282944	0.0178702	26.538	0.0113434	0.474	311.
0.90513412	0.07393020	0.0181417	26.937	0.0115448	0.463	311.
0.90627842	0.07507226	0.0184235	27.351	0.0117544	0.450	311.
0.90731596	0.07623521	0.0187104	27.772	0.0119686	0.436	312.
0.90856488	0.07736019	0.0189879	28.180	0.0121765	0.423	312.
0.90994835	0.07838415	0.0192405	28.551	0.0123664	0.410	312.
0.91149638	0.07928325	0.0194623	28.876	0.0125335	0.398	312.
0.91324869	0.08008189	0.0196594	29.166	0.0126824	0.388	312.
0.91525904	0.08083633	0.0198455	29.439	0.0128233	0.378	312.
0.91760207	0.08160416	0.0200349	29.717	0.0129670	0.367	312.
0.92038472	0.08242028	0.0202362	30.013	0.0131201	0.356	313.
0.92376608	0.08327069	0.0204460	30.321	0.0132800	0.343	313.
0.92799380	0.08411624	0.0206546	30.627	0.0134393	0.331	313.
0.93347646	0.08496482	0.0208640	30.934	0.0135997	0.318	313.
0.94094066	0.08584349	0.0210807	31.253	0.0137661	0.305	313.
0.95181744	0.08675360	0.0213053	31.582	0.0139388	0.290	313.
0.96937383	0.08769304	0.0215370	31.923	0.0141176	0.275	313.
1.00305497	0.08865761	0.0217750	32.272	0.0143017	0.260	314.
1.09605328	0.08979968	0.0220567	32.686	0.0145202	0.240	314.

Cu-54 kbar

in situ steady wave: sample thickness= 6.36mm
data entries= 72

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.03850000	0.00000000	0.0000000	0.000	0.0000000	0.000	300.
0.09765333	0.00120527	0.0002600	0.501	0.0000088	0.109	300.
0.11680667	0.00241053	0.0005218	0.995	0.0000350	0.208	300.
0.13596000	0.00361580	0.0007884	1.482	0.0000785	0.298	300.
0.15511333	0.00482107	0.0010588	1.962	0.0001391	0.378	301.
0.17426667	0.00602634	0.0013329	2.436	0.0002165	0.448	301.
0.19342000	0.00723161	0.0016109	2.903	0.0003106	0.510	301.
0.21257333	0.00843687	0.0018926	3.364	0.0004212	0.562	301.
0.23172667	0.00964214	0.0021781	3.818	0.0005480	0.605	301.
0.25088000	0.01084741	0.0024673	4.267	0.0006910	0.639	301.
0.25316000	0.01120718	0.0025543	4.400	0.0007362	0.648	302.
0.25557000	0.01156750	0.0026413	4.534	0.0007814	0.657	302.
0.25811000	0.01192838	0.0027285	4.667	0.0008269	0.666	302.
0.25963000	0.01228483	0.0028146	4.799	0.0008718	0.674	302.
0.26166000	0.01264349	0.0029012	4.932	0.0009172	0.683	302.
0.26369000	0.01300215	0.0029879	5.064	0.0009626	0.691	302.
0.26584000	0.01336136	0.0030746	5.197	0.0010082	0.700	302.
0.26787000	0.01406981	0.0032458	5.459	0.0010983	0.717	302.
0.26952000	0.01442681	0.0033320	5.591	0.0011438	0.725	302.
0.27116000	0.01478381	0.0034183	5.723	0.0011894	0.733	302.
0.27370000	0.01549445	0.0035899	5.986	0.0012805	0.750	302.
0.27560000	0.01620235	0.0037610	6.248	0.0013716	0.766	302.
0.27750000	0.01691028	0.0039320	6.510	0.0014630	0.782	302.
0.27928000	0.01761763	0.0041028	6.772	0.0015546	0.797	303.
0.28130000	0.01902566	0.0044430	7.293	0.0017380	0.828	303.
0.28283000	0.02008169	0.0046981	7.683	0.0018764	0.850	303.
0.28435000	0.02078793	0.0048687	7.945	0.0019694	0.865	303.
0.28549000	0.02184228	0.0051234	8.335	0.0021088	0.887	303.
0.28612000	0.02359401	0.0055466	8.983	0.0023420	0.922	303.
0.28662000	0.02744393	0.0064766	10.407	0.0028616	0.996	304.
0.28713000	0.03094407	0.0073222	11.702	0.0033422	1.057	305.
0.28751000	0.03444364	0.0081676	12.996	0.0038305	1.115	305.
0.28788000	0.04039177	0.0096045	15.197	0.0046782	1.201	306.
0.28801000	0.04528939	0.0107876	17.008	0.0053926	1.262	307.
0.28813000	0.05158620	0.0123088	19.338	0.0063327	1.328	308.
0.28826000	0.05753320	0.0137454	21.538	0.0072424	1.376	309.
0.28838000	0.06278008	0.0150129	23.479	0.0080624	1.407	310.
0.28850000	0.07047659	0.0168722	26.326	0.0092942	1.435	311.
0.28863000	0.07747352	0.0185625	28.914	0.0104432	1.441	312.
0.28875000	0.08307020	0.0199145	30.985	0.0113819	1.433	313.
0.28900000	0.08971738	0.0215202	33.444	0.0125191	1.408	314.
0.28950000	0.09601585	0.0230418	35.774	0.0136184	1.369	315.
0.29001000	0.09986575	0.0239718	37.198	0.0143006	1.338	316.
0.29064000	0.10371623	0.0249020	38.622	0.0149906	1.302	316.
0.29114000	0.10756613	0.0258320	40.047	0.0156881	1.260	317.
0.29165000	0.11211563	0.0269311	41.730	0.0165220	1.204	318.
0.29266000	0.11771669	0.0282841	43.802	0.0175627	1.124	318.
0.29405000	0.12192031	0.0292996	45.357	0.0183538	1.057	319.
0.29404000	0.12542213	0.0301456	46.652	0.0190194	0.996	320.
0.29582000	0.12857411	0.0309070	47.818	0.0196234	0.937	320.
0.29772000	0.13208032	0.0317540	49.115	0.0203008	0.868	321.
0.29899000	0.13488422	0.0324314	50.152	0.0208466	0.809	321.
0.30025000	0.13733827	0.0330242	51.060	0.0213273	0.755	322.
0.30152000	0.13944257	0.0335325	51.839	0.0217417	0.707	322.
0.30253000	0.14049640	0.0337871	52.228	0.0219500	0.683	322.
0.30431000	0.14155353	0.0340425	52.619	0.0221594	0.658	322.
0.30608000	0.14191113	0.0341289	52.752	0.0222301	0.649	322.
0.30824000	0.14262009	0.0343001	53.014	0.0223712	0.632	322.
0.30989000	0.14297711	0.0343864	53.146	0.0224422	0.623	321.
0.31204000	0.14368609	0.0345577	53.408	0.0225834	0.606	323.
0.31483000	0.14369870	0.0345606	53.412	0.0225858	0.606	323.
0.31741000	0.14405807	0.0346475	53.546	0.0226575	0.597	323.
0.31924000	0.14476654	0.0348187	53.808	0.0227990	0.579	323.
0.32066000	0.14477321	0.0348203	53.811	0.0228003	0.579	323.
0.32282000	0.14513240	0.0349070	53.943	0.0228721	0.570	323.
0.32497000	0.14514185	0.0349093	53.947	0.0228740	0.570	323.
0.32675000	0.14549936	0.0349957	54.079	0.0229455	0.561	323.
0.32801000	0.14550493	0.0349970	54.081	0.0229466	0.560	323.
0.32941000	0.14551100	0.0349985	54.083	0.0229478	0.560	323.
0.35000000	0.14605700	0.0351304	54.285	0.0230571	0.546	323.
0.37500000	0.14628500	0.0351855	54.370	0.0231028	0.541	323.

0.40000000	0.14639800	0.0352128	54.412	0.0231255	0.538	323.

Fe-105 kbar(shot# 15)

in situ steady wave: sample thickness= 6.30mm
data entries= 33

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
1.02317200	0.00008975	0.0000152	0.042	0.0000000	0.012	295.
1.02694300	0.00536057	0.0009040	2.495	0.0000000	0.737	295.
1.03835100	0.01327044	0.0022336	6.189	0.0000000	1.825	296.
1.05361600	0.01942660	0.0032648	9.074	0.0000000	2.671	297.
1.07274700	0.02295101	0.0038539	10.729	0.0000000	3.155	297.
1.10343400	0.02209235	0.0037115	10.323	0.0000036	3.033	297.
1.13022700	0.02210934	0.0037143	10.331	0.0000035	3.036	297.
1.16475700	0.02476536	0.0041613	11.570	0.0000159	3.388	297.
1.19157800	0.02653847	0.0044705	12.368	0.0000618	3.587	297.
1.21456500	0.02830916	0.0047878	13.144	0.0001368	3.758	297.
1.22603700	0.03095063	0.0052771	14.263	0.0003016	3.962	298.
1.23365300	0.03534581	0.0061336	16.035	0.0007112	4.174	298.
1.24126900	0.03974099	0.0070164	17.752	0.0012064	4.306	299.
1.24504100	0.04501181	0.0080751	19.812	0.0018084	4.455	299.
1.24879000	0.05203879	0.0094866	22.558	0.0026249	4.640	300.
1.25620500	0.07311721	0.0137205	30.796	0.0051670	5.098	303.
1.25969100	0.10209584	0.0195413	42.121	0.0088797	5.492	307.
1.26315400	0.13283058	0.0257149	54.132	0.0130769	5.614	312.
1.26670300	0.15654083	0.0304775	63.398	0.0164856	5.501	315.
1.26839000	0.17937055	0.0350632	72.320	0.0198993	5.224	319.
1.27007700	0.20132706	0.0394735	80.901	0.0232972	4.802	322.
1.27176400	0.22240067	0.0437064	89.136	0.0266581	4.255	325.
1.27345100	0.23293748	0.0458229	93.254	0.0283735	3.929	327.
1.28100300	0.24260104	0.0477640	97.031	0.0299663	3.600	328.
1.28862000	0.24699623	0.0486468	98.749	0.0306968	3.441	329.
1.30006000	0.25227199	0.0497065	100.810	0.0315786	3.242	329.
1.30768700	0.25578899	0.0504130	102.185	0.0321694	3.104	330.
1.31532500	0.25842804	0.0509431	103.216	0.0326142	2.999	330.
1.34216700	0.25844501	0.0509465	103.223	0.0326171	2.998	330.
1.35749500	0.25933284	0.0511248	103.570	0.0327670	2.962	330.
1.37282300	0.26022062	0.0513031	103.917	0.0329171	2.925	330.
1.39198600	0.26111081	0.0514819	104.265	0.0330677	2.889	330.
1.41114800	0.26200099	0.0516607	104.612	0.0332185	2.852	331.

Fe-131 kbar(shot# 16)

in situ steady wave: sample thickness= 6.31mm
data entries= 33

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
1.03164900	0.00097266	0.0001642	0.452	0.0000000	0.134	295.
1.03544400	0.00448735	0.0007569	2.088	0.0000000	0.617	295.
1.03921800	0.00975817	0.0016438	4.547	0.0000000	1.342	295.
1.04681900	0.01590948	0.0026760	7.425	0.0000000	2.187	296.
1.05827900	0.02030711	0.0034121	9.487	0.0000000	2.791	296.
1.07361900	0.02119488	0.0035610	9.903	0.0000019	2.912	296.
1.08508000	0.02559249	0.0043143	11.918	0.0000672	3.452	297.
1.10808400	0.02736318	0.0046248	12.711	0.0001194	3.645	297.
1.12345600	0.02561674	0.0043185	11.929	0.0000678	3.455	297.
1.13499000	0.02386789	0.0040158	11.136	0.0000306	3.251	297.
1.15415800	0.02563615	0.0043219	11.938	0.0000683	3.457	297.
1.16563900	0.02827762	0.0047868	13.116	0.0001522	3.739	297.
1.18480600	0.03004588	0.0051032	1[illegible].392	0.0002264	3.910	297.
1.20011400	0.03356785	0.0057457	1[illegible].407	0.0004171	4.210	298.
1.20389900	0.03796060	0.0065701	17.245	0.0007334	4.509	298.
1.21154300	0.04059965	0.0070777	18.322	0.0009646	4.651	298.
1.22302400	0.04324113	0.0075950	19.381	0.0012263	4.763	299.
1.23034900	0.07222217	0.0133210	30.895	0.0043968	5.710	303.
1.23088000	0.10997904	0.0207810	45.896	0.0089107	6.542	308.
1.23141200	0.14334797	0.0273739	59.154	0.0132369	6.905	313.
1.23194300	0.18110484	0.0348339	74.155	0.0184830	6.898	319.
1.23247400	0.21096157	0.0407329	86.017	0.0228748	6.581	324.
1.23300600	0.23993773	0.0464580	97.530	0.0273263	6.014	328.
1.23353700	0.26452361	0.0513156	107.298	0.0312390	5.332	332.
1.23406800	0.28647525	0.0556528	116.019	0.0348309	4.569	335.
1.23460000	0.30228043	0.0587756	122.299	0.0374712	3.930	338.
1.23513100	0.31193918	0.0606839	126.136	0.0391060	3.503	339.
1.24276400	0.31545635	0.0613788	127.534	0.0397052	3.340	340.
1.25039600	0.31897347	0.0620738	128.931	0.0403065	3.174	340.
1.26187800	0.32161493	0.0625957	129.981	0.0407594	3.047	340.
1.27337000	0.32337823	0.0629441	130.681	0.0410624	2.961	341.
1.28487200	0.32426368	0.0631190	131.033	0.0412147	2.917	341.
1.29638500	0.32427095	0.0631204	131.036	0.0412159	2.917	341.

21-6-9 S.Steel (shot# SSWP1S)

in situ steady wave: sample thickness= 4.18mm
data entries=100

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.72929126	0.00052085	0.0000909	0.234	0.0000000	0.071	298.
0.73091729	0.00173388	0.0003023	0.778	0.0000000	0.238	298.
0.73254332	0.00337598	0.0005884	1.515	0.0000000	0.463	298.
0.73412135	0.00537313	0.0009358	2.413	0.0000000	0.738	298.
0.73573822	0.00772777	0.0013450	3.473	0.0000000	1.061	299.
0.73756371	0.01020418	0.0017746	4.590	0.0000000	1.402	299.
0.73982417	0.01259672	0.0021891	5.670	0.0000000	1.732	299.
0.74247677	0.01476092	0.0025636	6.648	0.0000000	2.030	299.
0.74516173	0.01690890	0.0029347	7.621	0.0000000	2.327	299.
0.74776139	0.01910184	0.0033131	8.615	0.0000000	2.630	300.
0.75033013	0.02146878	0.0037209	9.689	0.0000000	2.957	300.
0.75286793	0.02436569	0.0042194	11.007	0.0000000	3.358	300.
0.75563249	0.02749434	0.0047567	12.432	0.0000000	3.791	300.
0.75983717	0.02981235	0.0051541	13.489	0.0000000	4.113	301.
0.76420612	0.03273766	0.0056549	14.826	0.0000000	4.519	301.
0.77038679	0.03612894	0.0062365	16.373	0.0000067	4.984	301.
0.78532614	0.03843453	0.0066469	17.386	0.0000630	5.252	301.
0.79868389	0.04063124	0.0070537	18.314	0.0001684	5.459	302.
0.81002642	0.04360211	0.0076283	19.516	0.0003883	5.667	302.
0.82010558	0.04615184	0.0081439	20.502	0.0006453	5.783	302.
0.82909323	0.04903218	0.0087449	21.582	0.0009913	5.863	303.
0.83561253	0.05184486	0.0093330	22.634	0.0013351	5.935	303.
0.84035659	0.05450497	0.0098891	23.630	0.0016626	6.001	303.
0.84402432	0.05703785	0.0104187	24.577	0.0019765	6.062	304.
0.84697982	0.05952427	0.0109385	25.507	0.0022868	6.120	304.
0.84943455	0.06200631	0.0114575	26.436	0.0025984	6.175	305.
0.85152108	0.06449631	0.0119781	27.368	0.0029131	6.229	305.
0.85332747	0.06699578	0.0125006	28.303	0.0032309	6.281	305.
0.85491487	0.06950327	0.0130249	29.241	0.0035517	6.331	306.
0.85632729	0.07201702	0.0135504	30.182	0.0038753	6.379	306.
0.85759735	0.07453569	0.0140770	31.124	0.0042015	6.424	306.
0.85874984	0.07705844	0.0146045	32.068	0.0045302	6.468	307.
0.85980397	0.07958475	0.0151327	33.013	0.0048614	6.510	307.
0.86077493	0.08211432	0.0156615	33.959	0.0051949	6.550	308.
0.86167490	0.08464699	0.0161910	34.907	0.0055308	6.588	308.
0.86251379	0.08718260	0.0167212	35.856	0.0058691	6.623	308.
0.86329976	0.08972106	0.0172519	36.805	0.0062097	6.657	309.
0.86403961	0.09226223	0.0177832	37.756	0.0065525	6.688	309.
0.86473906	0.09480599	0.0183130	38.708	0.0068977	6.718	310.
0.86540297	0.09735220	0.0188474	39.660	0.0072451	6.745	310.
0.86603550	0.09990073	0.0193802	40.614	0.0075948	6.770	310.
0.86664025	0.10245141	0.0199135	41.568	0.0079467	6.793	311.
0.86722036	0.10500409	0.0204472	42.523	0.0083008	6.814	311.
0.86777856	0.10755862	0.0209813	43.479	0.0086570	6.833	312.
0.86831729	0.11011485	0.0215157	44.435	0.0090153	6.850	312.
0.86883871	0.11267261	0.0220505	45.392	0.0093758	6.864	312.
0.86934475	0.11523176	0.0225855	46.350	0.0097383	6.877	313.
0.86983716	0.11779215	0.0231208	47.308	0.0101028	6.887	313.
0.87031752	0.12035364	0.0236561	48.266	0.0104694	6.896	314.
0.87078729	0.12291610	0.0241921	49.225	0.0108380	6.902	314.
0.87124782	0.12547941	0.0247280	50.184	0.0112085	6.906	315.
0.87170034	0.12804343	0.0252641	51.143	0.0115810	6.907	315.
0.87214603	0.13060806	0.0258003	52.103	0.0119554	6.907	315.
0.87258599	0.13317319	0.0263366	53.062	0.0123317	6.905	316.
0.87302126	0.13573873	0.0268730	54.022	0.0127098	6.900	316.
0.87345287	0.13830459	0.0274094	54.982	0.0130898	6.893	317.
0.87388179	0.14087068	0.0279459	55.942	0.0134716	6.885	317.
0.87430899	0.14343694	0.0284825	56.903	0.0138552	6.874	318.
0.87473540	0.14600329	0.0290190	57.863	0.0142406	6.861	318.
0.87516199	0.14856970	0.0295556	58.823	0.0146277	6.845	318.
0.87558970	0.15113611	0.0300922	59.783	0.0150166	6.828	319.
0.87601952	0.15370249	0.0306287	60.743	0.0154072	6.809	319.
0.87645243	0.15626881	0.0311653	61.703	0.0157996	6.787	320.
0.87688949	0.15883506	0.0317018	62.664	0.0161937	6.763	320.
0.87733178	0.16140123	0.0322383	63.624	0.0165894	6.737	321.
0.87778044	0.16396732	0.0327748	64.584	0.0169869	6.710	321.
0.87823671	0.16653335	0.0333113	65.544	0.0173860	6.679	321.
0.87870190	0.16909935	0.0338478	66.504	0.0177868	6.647	322.
0.87917744	0.17166533	0.0343843	67.464	0.0181893	6.613	322.
0.87966490	0.17423134	0.0349208	68.424	0.0185934	6.577	323.
0.88016598	0.17679744	0.0354573	69.384	0.0189993	6.538	323.

0.88068261	0.17936369	0.0359938	70.344	0.0194067	6.498	324.
0.88121691	0.18193014	0.0365304	71.304	0.0198159	6.455	324.
0.88177127	0.18449689	0.0370670	72.265	0.0202267	6.410	324.
0.88234843	0.18706400	0.0376038	73.225	0.0206392	6.363	325.
0.88295149	0.18963159	0.0381406	74.186	0.0210534	6.314	325.
0.88358401	0.19219974	0.0386775	75.147	0.0214693	6.263	326.
0.88425016	0.19476856	0.0392146	76.108	0.0218869	6.210	326.
0.88495477	0.19733815	0.0397518	77.069	0.0223062	6.154	327.
0.88570355	0.19990864	0.0402892	78.031	0.0227273	6.097	327.
0.88650328	0.20248014	0.0408269	78.993	0.0231501	6.037	327.
0.88736210	0.20505277	0.0413647	79.955	0.0235746	5.975	328.
0.88828987	0.20762664	0.0419029	80.918	0.0240009	5.912	328.
0.88929865	0.21020187	0.0424413	81.882	0.0244289	5.846	329.
0.89040340	0.21277857	0.0429800	82.846	0.0248588	5.777	329.
0.89162292	0.21535687	0.0435191	83.811	..0252904	5.707	329.
0.89298110	0.21793684	0.0440585	84.776	0.0257239	5.635	330.
0.89450891	0.22051854	0.0445982	85.742	0.0261592	5.560	330.
0.89624717	0.22310209	0.0451384	86.708	0.0265963	5.483	331.
0.89825080	0.22568756	0.0456789	87.676	0.0270352	5.404	331.
0.90059557	0.22827507	0.0462199	88.644	0.0274760	5.323	332.
0.90338891	0.23086471	0.0467613	89.613	0.0279187	5.240	332.
0.90678841	0.23345663	0.0473032	90.582	0.0283632	5.155	332.
0.91103465	0.23605108	0.0478457	91.553	0.0288097	5.067	333.
0.91651373	0.23864840	0.0483887	92.525	0.0292581	4.977	333.
0.92388533	0.24124917	0.0489325	93.498	0.0297087	4.885	334.
0.93437302	0.24385425	0.0494771	94.473	0.0301614	4.790	334.
0.95051595	0.24647269	0.0500246	95.452	0.0306179	4.693	334.
0.97852299	0.24927515	0.0506105	96.501	0.0311082	4.587	335.
1.03822588	0.25270865	0.0513283	97.785	0.0317111	4.454	335.

U-75 kbar(shot# AV6)

in situ steady wave: sample thickness= 7.54mm
data entries=100

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.11403600	0.00126315	0.0003666	0.824	0.0000000	0.315	296.
0.13101390	0.00265666	0.0007737	1.741	0.0000000	0.665	296.
0.14619140	0.00407016	0.0011805	2.658	0.0000000	1.014	296.
0.15981120	0.00547366	0.0015870	3.576	0.0000000	1.363	296.
0.17309631	0.00687717	0.0019932	4.494	0.0000000	1.711	296.
0.18636747	0.00828067	0.0023991	5.413	0.0000000	2.058	296.
0.19868202	0.00968417	0.0028046	6.333	0.0000000	2.405	297.
0.20791988	0.01108768	0.0032099	7.254	0.0000000	2.752	297.
0.22155895	0.01249118	0.0036149	8.175	0.0000000	3.098	297.
0.23457365	0.01389468	0.0040196	9.097	0.0000000	3.443	297.
0.24892353	0.01529819	0.0044240	10.019	0.0000000	3.788	297.
0.26517047	0.01670169	0.0048282	10.943	0.0000000	4.133	298.
0.27416927	0.01810520	0.0052320	11.867	0.0000001	4.477	298.
0.29492527	0.01950870	0.0056445	12.771	0.0000243	4.797	298.
0.32633398	0.02091220	0.0060721	13.644	0.0000896	5.080	298.
0.35936521	0.02231571	0.0065148	14.487	0.0001948	5.326	298.
0.39361306	0.02371921	0.0069726	15.301	0.0003391	5.537	299.
0.42603635	0.02512271	0.0074456	16.090	0.0005215	5.714	299.
0.45811453	0.02652622	0.0079338	16.855	0.0007412	5.858	299.
0.47608964	0.02792972	0.0084370	17.596	0.0009974	5.970	300.
0.50072155	0.02933322	0.0089552	18.316	0.0012808	6.052	300.
0.52084650	0.03073673	0.0094785	19.029	0.0015933	6.122	301.
0.53674324	0.03214023	0.0100018	19.742	0.0018994	6.190	301.
0.54846936	0.03354373	0.0105251	20.455	0.0022071	6.257	301.
0.56156347	0.03494724	0.0110483	21.168	0.0025164	6.323	302.
0.56969593	0.03635074	0.0115716	21.881	0.0028273	6.387	302.
0.57840225	0.03775424	0.0120949	22.594	0.0031398	6.449	303.
0.58923620	0.03915775	0.0126182	23.307	0.0034539	6.510	303.
0.59544991	0.04056125	0.0131415	24.020	0.0037695	6.569	304.
0.60434506	0.04196475	0.0136648	24.733	0.0040867	6.626	304.
0.61003466	0.04336826	0.0141881	25.446	0.0044055	6.682	304.
0.61243198	0.04477176	0.0147114	26.159	0.0047258	6.736	305.
0.62000641	0.04617527	0.0152346	26.872	0.0050476	6.789	305.
0.62671995	0.04757877	0.0157579	27.585	0.0053710	6.840	306.
0.63046813	0.04898227	0.0162812	28.298	0.0056959	6.890	306.
0.63617543	0.05038578	0.0168045	29.011	0.0060223	6.938	307.
0.64393608	0.05178928	0.0173278	29.724	0.0063503	6.984	307.
0.64966391	0.05319278	0.0178511	30.437	0.0066797	7.029	308.
0.65694466	0.05459629	0.0183744	31.150	0.0070106	7.072	308.
0.66326186	0.05599979	0.0188977	31.863	0.0073430	7.113	309.
0.66830612	0.05740329	0.0194209	32.576	0.0076769	7.154	309.
0.67399550	0.05880680	0.0199442	33.288	0.0080123	7.192	309.
0.67968659	0.06021030	0.0204675	34.001	0.0083491	7.229	310.
0.68422444	0.06161380	0.0209908	34.714	0.0086874	7.264	310.
0.68809866	0.06301731	0.0215141	35.427	0.0090271	7.298	311.
0.69257360	0.06442081	0.0220374	36.140	0.0093682	7.330	311.
0.69664539	0.06582431	0.0225607	36.853	0.0097108	7.361	312.
0.69988576	0.06722782	0.0230840	37.566	0.0100548	7.390	312.
0.70287945	0.06863132	0.0236072	38.279	0.0104002	7.417	313.
0.70614192	0.07003482	0.0241305	38.992	0.0107470	7.443	313.
0.70913655	0.07143833	0.0246538	39.705	0.0110953	7.467	314.
0.71112629	0.07284183	0.0251771	40.418	0.0114449	7.490	314.
0.71424519	0.07424534	0.0257004	41.131	0.0117958	7.511	315.
0.71670879	0.07564884	0.0262237	41.844	0.0121482	7.531	315.
0.71919309	0.07705234	0.0267470	42.557	0.0125019	7.549	316.
0.72165120	0.07845585	0.0272703	43.270	0.0128570	7.565	316.
0.72327997	0.07985935	0.0277935	43.983	0.0132134	7.580	317.
0.72504042	0.08126285	0.0283168	44.696	0.0135711	7.594	317.
0.72710362	0.08266636	0.0288401	45.409	0.0139302	7.606	318.
0.72921553	0.08406986	0.0293634	46.122	0.0142906	7.616	318.
0.73099641	0.08547336	0.0298867	46.835	0.0146523	7.625	319.
0.73304073	0.08687687	0.0304100	47.548	0.0150153	7.632	319.
0.73512625	0.08828037	0.0309333	48.261	0.0153796	7.637	320.
0.73720201	0.08968387	0.0314566	48.974	0.0157452	7.641	320.
0.73926034	0.09108738	0.0319798	49.687	0.0161121	7.644	321.
0.74104794	0.09249088	0.0325031	50.400	0.0164802	7.645	321.
0.74283553	0.09389438	0.0330264	51.113	0.0168496	7.644	322.
0.74454333	0.09529789	0.0335497	51.826	0.0172203	7.642	322.
0.74625427	0.09670139	0.0340730	52.539	0.0175922	7.638	323.
0.74807678	0.09810489	0.0345963	53.252	0.0179653	7.633	323.
0.74990750	0.09950840	0.0351196	53.964	0.0183397	7.626	324.

[illegible]	0.10091190	0.0356429	54.677	0.0187152	7.618	324.
[illegible]	0.10231541	0.0361661	55.390	0.0190920	7.608	325.
[illegible]	0.10371891	0.0366894	56.103	0.0194700	7.597	325.
[illegible]	0.10512241	0.0372127	56.816	0.0198492	7.584	326.
[illegible]	0.10652592	0.0377360	57.529	0.0202296	7.569	326.
[illegible]	0.10792942	0.0382593	58.242	0.0206112	7.553	327.
[illegible]	0.10933292	0.0387826	58.955	0.0209939	7.535	327.
[illegible]	0.11073643	0.0393059	59.668	0.0213778	7.516	328.
[illegible]	0.11213993	0.0398292	60.381	0.0217628	7.496	328.
[illegible]	0.11354343	0.0403525	61.094	0.0221490	7.473	329.
[illegible]	0.11494694	0.0408757	61.807	0.0225363	7.450	330.
[illegible]	0.11635044	0.0413990	62.520	0.0229248	7.424	330.
[illegible]	0.11775394	0.0419223	63.233	0.0233143	7.397	331.
[illegible]	0.11915745	0.0424456	63.946	0.0237050	7.369	331.
0.77898923	0.12056095	0.0429689	64.659	0.0240968	7.339	332.
0.78163335	0.12196445	0.0434922	65.372	0.0244897	7.308	332.
0.78424728	0.12336796	0.0440155	66.085	0.0248836	7.275	333.
0.78678742	0.12477146	0.0445388	66.798	0.0252787	7.240	333.
0.78976473	0.12617496	0.0450620	67.511	0.0256748	7.204	334.
0.79297213	0.12757847	0.0455853	68.224	0.0260720	7.167	334.
0.79862207	0.12898197	0.0461086	68.937	0.0264702	7.128	335.
0.80572662	0.13038548	0.0466319	69.650	0.0268695	7.087	335.
0.81305387	0.13178898	0.0471552	70.363	0.0272698	7.045	336.
0.82677154	0.13319248	0.0476785	71.076	0.0276712	7.001	336.
0.84221743	0.13459599	0.0482018	71.789	0.0280736	6.956	337.
0.86489177	0.13599949	0.0487251	72.502	0.0284770	6.909	337.
0.88652560	0.13740299	0.0492483	73.215	0.0288814	6.861	338.
0.91265575	0.13880650	0.0497716	73.928	0.0292868	6.811	338.
0.96820000	0.14021000	0.0502949	74.641	0.0296932	6.760	339.

U-96 kbar(shot# AV10)

in situ steady wave: sample thickness= 7.57mm
data entries=100

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.11934827	0.00211081	0.0006125	1.378	0.0000000	0.526	296.
0.13489384	0.00388949	0.0011282	2.540	0.0000000	0.969	296.
0.14852182	0.00566817	0.0016433	3.703	0.0000000	1.411	296.
0.16441794	0.00744685	0.0021580	4.867	0.0000000	1.852	297.
0.17794989	0.00922553	0.0026721	6.033	0.0000000	2.292	297.
0.19575970	0.01100420	0.0031858	7.199	0.0000000	2.731	297.
0.20916427	0.01278288	0.0036991	8.367	0.0000000	3.170	297.
0.22206583	0.01456156	0.0042118	9.535	0.0000000	3.607	297.
0.23084302	0.01634024	0.0047241	10.705	0.0000000	4.044	298.
0.24220469	0.01811892	0.0052359	11.876	0.0000000	4.480	298.
0.25662062	0.01989760	0.0057475	13.047	0.0000006	4.915	298.
0.28253816	0.02167628	0.0062726	14.188	0.0000394	5.313	298.
0.30594842	0.02345495	0.0068195	15.284	0.0001373	5.656	299.
0.34544409	0.02523363	0.0073882	16.338	0.0002927	5.948	299.
0.37847222	0.02701231	0.0079786	17.353	0.0005041	6.189	299.
0.40934998	0.02879099	0.0085908	18.332	0.0007701	6.382	300.
0.44362781	0.03056967	0.0092247	19.277	0.0010894	6.529	300.
0.47328301	0.03234835	0.0098745	20.199	0.0014475	6.642	301.
0.50081414	0.03412703	0.0105250	21.120	0.0018099	6.751	301.
0.52609910	0.03590571	0.0111756	22.041	0.0021749	6.857	302.
0.54920405	0.03768438	0.0118261	22.963	0.0025424	6.961	303.
0.56424603	0.03946306	0.0124766	23.884	0.0029125	7.062	303.
0.57152005	0.04124174	0.0131272	24.805	0.0032850	7.161	304.
0.57948809	0.04302042	0.0137777	25.726	0.0036602	7.258	304.
0.58775384	0.04479910	0.0144283	26.647	0.0040378	7.352	305.
0.59543097	0.04657778	0.0150788	27.568	0.0044179	7.443	305.
0.60298464	0.04835646	0.0157294	28.489	0.0048005	7.532	306.
0.60825115	0.05013514	0.0163799	29.410	0.0051855	7.619	306.
0.61367203	0.05191381	0.0170305	30.331	0.0055730	7.703	307.
0.61906082	0.05369249	0.0176810	31.252	0.0059629	7.785	308.
0.62447406	0.05547117	0.0183316	32.173	0.0063553	7.864	308.
0.63016088	0.05724985	0.0189821	33.094	0.0067500	7.940	309.
0.63492273	0.05902853	0.0196326	34.016	0.0071471	8.015	309.
0.63992717	0.06080721	0.0202832	34.937	0.0075467	8.086	310.
0.64397163	0.06258589	0.0209337	35.858	0.0079485	8.156	311.
0.64687696	0.06436456	0.0215843	36.779	0.0083528	8.223	311.
0.65101995	0.06614324	0.0222348	37.700	0.0087593	8.287	312.
0.65399487	0.06792192	0.0228854	38.621	0.0091682	8.349	312.
0.65642470	0.06970060	0.0235359	39.542	0.0095794	8.408	313.
0.65900508	0.07147928	0.0241865	40.463	0.0099928	8.465	314.
0.66218751	0.07325796	0.0248370	41.384	0.0104086	8.520	314.
0.66456825	0.07503664	0.0254876	42.305	0.0108265	8.572	315.
0.66684414	0.07681532	0.0261381	43.226	0.0112468	8.622	316.
0.66902590	0.07859399	0.0267886	44.147	0.0116692	8.669	316.
0.67044164	0.08037267	0.0274392	45.069	0.0120939	8.714	31[illegible].
0.67177148	0.08215135	0.0280897	45.990	0.0125207	8.757	31[illegible].
0.67291335	0.08393003	0.0287403	46.911	0.0129498	8.797	318.
0.67435152	0.08570871	0.0293908	47.832	0.0133810	8.834	319.
0.67591233	0.08748739	0.0300414	48.753	0.0138143	8.869	320.
0.67741886	0.08926607	0.0306919	49.674	0.0142498	8.902	320.
0.67891752	0.09104474	0.0312425	50.595	0.0146874	8.933	321.
0.68067185	0.09282342	0.0319930	51.516	0.0151271	8.960	322.
0.68237494	0.09460210	0.0326436	52.437	0.0155689	8.986	322.
0.68359759	0.09638078	0.0332941	53.358	0.0160127	9.009	323.
0.68480526	0.09815946	0.0339446	54.279	0.0164586	9.030	324.
0.68586518	0.09993814	0.0345952	55.201	0.0169065	9.048	324.
0.68693499	0.10171682	0.0352457	56.122	0.0173565	9.064	325.
0.68791120	0.10349550	0.0358963	57.043	0.0178084	9.077	326.
0.68884719	0.10527417	0.0365468	57.964	0.0182624	9.088	326.
0.68949693	0.10705285	0.0371974	58.885	0.0187183	9.097	327.
0.69014548	0.10883153	0.0378479	59.806	0.0191761	9.103	328.
0.69091390	0.11061021	0.0384985	60.727	0.0196359	9.107	328.
0.69183391	0.11238889	0.0391490	61.648	0.0200977	9.108	329.
0.69281255	0.11416757	0.0397996	62.569	0.0205613	9.107	330.
0.69404412	0.11594625	0.0404501	63.490	0.0210268	9.104	330.
0.69525859	0.11772492	0.0411006	64.411	0.0214942	9.098	331.
0.69630159	0.11950360	0.0417512	65.332	0.0219635	9.090	332.
0.69734458	0.12128228	0.0424017	66.254	0.0224346	9.079	333.
0.69835651	0.12306096	0.0430523	67.175	0.0229076	9.063	333.
0.69930514	0.12483964	0.0437028	68.096	0.0233823	9.051	334.
[illegible]	[illegible]12661832	0.044[illegible]	69.01[illegible]	[illegible]36589	9.0[illegible]	335.

0.70106609	0.12839700	0.0450039	69.938	0.0243372	9.013	335.
0.70183942	0.13017568	0.0456545	70.859	0.0248173	8.991	336.
0.70259606	0.13195435	0.0463050	71.780	0.0252991	8.966	337.
0.70328441	0.13373303	0.0469556	72.701	0.0257827	8.939	338.
0.70397830	0.13551171	0.0476061	73.622	0.0262680	8.909	338.
0.70476080	0.13729039	0.0482566	74.543	0.0267550	8.877	339.
0.70560845	0.13906907	0.0489072	75.464	0.0272437	8.843	340.
0.70646825	0.14084775	0.0495577	76.385	0.0277341	8.806	340.
0.70734203	0.14262643	0.0502083	77.307	0.0282261	8.767	341.
0.70822865	0.14440511	0.0508588	78.228	0.0287198	8.726	342.
0.70985265	0.14618378	0.0515094	79.149	0.0292150	8.682	343.
0.71195457	0.14796246	0.0521599	80.070	0.0297119	8.635	343.
0.71334184	0.14974114	0.0528105	80.991	0.0302104	8.587	344.
0.71579320	0.15151982	0.0534610	81.912	0.0307105	8.536	345.
0.71872941	0.15329850	0.0541116	82.833	0.0312122	8.483	345.
0.72255910	0.15507718	0.0547621	83.754	0.0317154	8.427	346.
0.72681288	0.15685586	0.0554126	84.675	0.0322201	8.369	347.
0.73070365	0.15863453	0.0560632	85.596	0.0327264	8.309	348.
0.73389741	0.16041321	0.0567137	86.517	0.0332341	8.246	348.
0.74052069	0.16219189	0.0573643	87.438	0.0337434	8.181	349.
0.74851810	0.16397057	0.0580148	88.360	0.0342542	8.113	350.
0.75840115	0.16574925	0.0586654	89.281	0.0347664	8.043	350.
0.76948007	0.16752793	0.0593159	90.202	0.0352800	7.971	351.
0.78213643	0.16930661	0.0599665	91.123	0.0357951	7.897	352.
0.79393061	0.17108529	0.0606170	92.044	0.0363116	7.820	352.
0.80918208	0.17286396	0.0612676	92.965	0.0368296	7.741	353.
0.82999511	0.17464264	0.0619181	93.886	0.0373489	7.659	354.
0.86306895	0.17642132	0.0625686	94.807	0.0378696	7.575	354.
0.92400000	0.17820000	0.0632192	95.728	0.0383916	7.489	355.

U-116 kbar(shot# AV8)

In situ steady wave: sample thickness= 7.53mm
\# data entries=100

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.12506880	0.00212550	0.0006168	1.387	0.0000000	0.530	296.
0.14800174	0.00427049	0.0012385	2.789	0.0000000	1.064	296.
0.16720661	0.00641549	0.0018596	4.192	0.0000000	1.596	296
0.18345254	0.00856048	0.0024799	5.597	0.0000000	2.128	297.
0.19496456	0.01070548	0.0030996	7.003	0.0000000	2.658	297.
0.21624633	0.01285047	0.0037186	8.411	0.0000000	3.186	297.
0.23452326	0.01499547	0.0043368	9.820	0.0000000	3.714	298.
0.25253356	0.01714046	0.0049544	11.231	0.0000000	4.240	298.
0.27198687	0.01928546	0.0055713	12.644	0.0000000	4.765	298.
0.31131892	0.02143045	0.0061947	14.042	0.0000196	5.271	299.
0.36563069	0.02357545	0.0068527	15.367	0.0001335	5.689	299.
0.40989100	0.02572044	0.0075482	16.620	0.0003455	6.019	299.
0.45033420	0.02786544	0.0082812	17.809	0.0006518	6.264	300.
0.47439021	0.03001043	0.0090469	18.947	0.0010385	6.440	300.
0.49400484	0.03215543	0.0098174	20.078	0.0014399	6.602	301.
0.50852710	0.03430042	0.0105880	21.209	0.0018451	6.761	302.
0.51837734	0.03644542	0.0113585	22.340	0.0022539	6.91[illegible]	302.
0.52524779	0.03859041	0.0121290	23.471	0.0026664	7.068	303.
0.53254519	0.04073541	0.0128995	24.602	0.0030826	7.216	303.
0.53875106	0.04288040	0.0136700	25.733	0.0035024	7.361	304.
0.54418586	0.04502540	0.0144405	26.864	0.0039258	7.502	305.
0.54911920	0.04717039	0.0152111	27.995	0.0043528	7.640	305.
0.55413387	0.04931539	0.0159816	29.126	0.0047835	7.774	306.
0.55892739	0.05146038	0.0167521	30.257	0.0052176	7.904	307.
0.56286793	0.05360538	0.0175226	31.388	0.0056554	8.031	307.
0.56615833	0.05575037	0.0182931	32.519	0.0060966	8.155	308.
0.56[illegible]02249	0.05789537	0.0190637	33.650	0.0065414	8.275	309.
0.57059077	0.06004036	0.0198342	34.781	0.0069896	8.392	310.
0.57391628	0.06218536	0.0206047	35.912	0.0074413	8.505	310.
0.57907783	0.06433035	0.0213752	37.043	0.0078964	8.615	311.
0.58499977	0.06647535	0.0221457	38.174	0.0083549	8.721	312.
0.58807037	0.06862034	0.0229162	39.305	0.0088168	8.824	312.
0.59084859	0.07076534	0.0236868	40.436	0.0092821	8.923	313.
0.59300632	0.07291033	0.0244573	41.567	0.0097508	9.019	314.
0.59495893	0.07505533	0.0252278	42.698	0.0102227	9.111	315.
0.59702265	0.07720032	0.0259983	43.829	0.0106980	9.200	315.
0.59725923	0.07934532	0.0267688	44.960	0.0111765	9.285	316.
0.59860023	0.08149031	0.0275393	46.091	0.0116582	9.367	317.
0.60032337	0.08363531	0.0283099	47.222	0.0121432	9.446	318.
0.60234836	0.08578030	0.0290804	48.353	0.0126314	9.521	319.
0.60256018	0.08792530	0.0298509	49.484	0.0131228	9.593	319.
0.60292912	0.09007029	0.0306214	50.615	0.0136173	9.661	320.
0.60446354	0.09221529	0.0313919	51.746	0.0141149	9.726	321.
0.60603406	0.09436028	0.0321624	52.877	0.0146156	9.787	322.
0.60762917	0.09650528	0.0329330	54.008	0.0151194	9.845	323.
0.60794752	0.09865027	0.0337035	55.139	0.0156263	9.900	323.
0.60811077	0.10079527	0.0344740	56.270	0.0161361	9.951	324.
0.60825051	0.10294026	0.0352445	57.401	0.0166490	9.999	325.
0.60839024	0.10508526	0.0360150	58.532	0.0171648	10.043	326.
0.60970253	0.10723025	0.0367855	59.663	0.0176836	10.084	327.
0.61105433	0.10937525	0.0375561	60.793	0.0182053	10.122	328.
0.61175361	0.11152024	0.0383266	61.924	0.0187299	10.156	329.
0.61287023	0.11366524	0.0390971	63.055	0.0192573	10.187	329.
0.61417591	0.11581023	0.0398676	64.186	0.0197876	10.214	[illegible]
0.61531810	0.11795523	0.0406381	65.317	0.0203207	10.238	331.
0.61610217	0.12010022	0.0414087	66.448	0.0208566	10.259	332.
0.61688624	0.12224522	0.0421792	67.579	0.0213952	10.276	333.
0.61739648	0.12439021	0.0429497	68.710	0.0219[illegible]66	10.290	334.
0.617[illegible]0408	0.12653521	0.0437202	69.841	0.0224807	10.301	335.
0.618[illegible]9883	0.12868020	0.0444907	70.972	0.0230275	10.308	336.
0.61882041	0.13082520	0.0452612	72.103	0.0235770	10.311	336.
0.61953506	0.13297019	0.0460318	73.234	0.0241290	10.312	337.
0.62048131	0.13511519	0.0468023	74.365	0.0246837	10.309	338.
0.62128287	0.13726018	0.0475728	75.496	0.0252410	10.302	339.
0.62162133	0.13940518	0.0483433	76.627	0.0258008	10.293	340.
0.62195979	0.14155017	0.0491138	77.758	0.0263631	10.280	341.
0.62229825	0.14269517	0.0498843	78.889	[illegible]	10.263	342.
0.62271102	0.14584016	0.0506549	80.0[illegible]	[illegible]	10.244	343.
0.62313959	0.14798516	0.0514254	81.15[illegible]	[illegible]	10.220	344.
0.62356816	[illegible]	0.0521959	[illegible]	[illegible]	10.194	345.
0.62406708	[illegible]	0.0529664	[illegible]	[illegible]	10.164	346.

0.62459725	0.15442014	0.0537369	8[illegible].544	0.0297887	10.131	346.
0.62508511	0.15656514	0.0545074	85.675	0.0303681	10.095	347.
0.62551662	0.15871013	0.0552780	86.806	0.0309497	10.055	348.
0.62594814	0.16085513	0.0560485	87.937	0.0315336	10.012	349.
0.62654963	0.1630001[illegible]	0.0568190	89.068	0.0321198	9.965	350.
0.62724343	0.16514512	0.0575895	[illegible]	0.032708[illegible]	9.915	351.
0.62799127	0.16729011	0.0583600	91.33[illegible]	0.0332990	9.362	352.
0.6288097[illegible]	0.16943511	0.0[illegible]06	92.461	0.0338919	9.806	353.
0.62968536	0.17158010	0.0599011	93.592	0.0344869	9.746	354.
0.63058535	0.17372510	0.0606716	[illegible]1.7[illegible]	0.0350841	9.683	355.
0.63151903	0.17587009	0.0614421	95.854	0.0356835	9.617	356.
0.63245326	0.17801509	[illegible]	96.985	0.0362849	9.547	356.
0.63339078	0.18016008	0.0629831	[illegible].116	0.0368884	9.474	357.
0.63433572	0.18230508	0.0637537	99.[illegible]	0.0374940	9.398	358.
0.63528065	0.18445007	[illegible]0645242	100.378	0.0381016	9.318	359.
0.63622558	0.18659507	0.065[illegible]47	101.509	0.0387113	9.235	360.
0.63771694	[illegible]18874006	0.0660652	[illegible].640	0.[illegible]229	9.149	361.
0.6[illegible]943678	0.1908[illegible]	0.0668357	103.771	0.0399364	9.059	362.
0.6426[illegible]00	0.19303005	0.0676062	104.901	0.0405520	8.967	363.
0.64869497	0.19517505	0.068[illegible]	[illegible]	0.0411694	8.870	364.
0.65254011	0.19732004	0.0691473	107.16[illegible]	0.0417887	8.771	364.
0.65820988	0.19946504	0.0699178	108.294	0.0424099	8.668	365.
0.66371870	0.2016100[illegible]	0.0[illegible]	1[illegible]	0.0430330	8.562	366.
0.67054992	0.20375503	0.0714588	110.556	0.0436579	8.453	367.
0.67868988	0.2059000[illegible]	0.0722293	111.687	0.0442846	8.341	368.
0.6984862[illegible]	0.2080450[illegible]	0.0729999	112.818	0.0449131	8.225	369.
0.72409031	0.21019001	0.0737704	11[illegible].949	0.0455433	8.106	370.
0.7598[illegible]394	0.21233[illegible]1	0.0745409	115.080	0.0461753	7.984	371.
0.82330000	0.21448000	0.0753114	116.211	0.0468090	7.858	371.

U-127 kbar(shot# AV7)

in situ steady wave: sample thickness= 7.62mm
data entries=100

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stres'	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.11476005	0.00209275	0.0006073	1.366	0.0000000	0.522	296.
0.14476178	0.00441247	0.0012797	2.882	0.0000000	1.099	296.
0.16034345	0.00673219	0.0019512	4.399	0.0000000	1.675	296.
0.17576609	0.00905191	0.0026220	5.919	0.0000000	2.249	297.
0.19975229	0.01137163	0.0032[illegible]9	7.440	0.0000000	2.822	297.
0.22017994	0.01369135	0.0039610	8.963	0.0000000	3.393	297.
0.23725800	0.01601107	0.0046293	10.488	0.0000000	3.963	298.
0.25926685	0.01833079	0.0052969	12.015	0.0000000	4.532	298.
0.28187269	0.02065051	0.0059664	13.537	0.0000078	5.092	298.
0.32364617	0.02297023	0.0066560	15.016	0.0000722	5.598	299.
0.37866767	0.02528994	0.0073688	16.445	0.0002008	6.045	299.
0.41997877	0.02760966	0.0081048	17.830	0.0003924	6.434	300.
0.46159768	0.02992938	0.0088641	19.173	0.0006459	6.768	300.
0.48130771	0.03224910	0.0096465	20.475	0.0009602	7.048	301.
0.50132917	0.03456882	0.0104522	21.740	0.0013341	7.275	301.
0.51194267	0.03688854	0.0112767	22.977	0.0017566	7.460	302.
0.52233520	0.03920826	0.0121030	24.210	0.0021874	7.638	303.
0.52867945	0.04152798	0.0129293	25.444	0.0026226	7.811	303.
0.53430826	0.04384770	0.0137555	26.677	0.0030619	7.981	304.
0.53981300	0.04616742	0.0145818	27.911	0.0035055	8.146	305.
0.54273447	0.04848714	0.0154080	29.144	0.0039534	8.307	305.
0.54601986	0.05080686	0.0162343	30.378	0.0044054	8.464	306.
0.55066599	0.05312658	0.0170606	31.611	0.0048616	8.618	307.
0.55561126	0.05544630	0.0178868	32.845	0.0053220	8.767	308.
0.56024468	0.05776602	0.0187131	34.078	0.0057864	8.912	308.
0.56281070	0.06008574	0.0195393	35.312	0.0062550	9.053	309.
0.56640030	0.06240546	0.0203656	36.545	0.0067276	9.190	310.
0.56961310	0.06472518	0.0211919	37.779	0.0072043	9.323	311.
0.57366114	0.06704490	0.0220181	39.012	0.0076850	9.452	312.
0.57650900	0.06936462	0.0228444	40.245	0.0081697	9.577	312.
0.57897245	0.07168434	0.0236706	41.479	0.0086583	9.698	313.
0.58120700	0.07400406	0.0244969	42.712	0.0091509	9.815	314.
0.58518756	0.07632378	0.0253232	43.946	0.0096474	9.928	315.
0.58965618	0.07864350	0.0261494	45.179	0.0101477	10.037	316.
0.59270113	0.08096322	0.0269757	46.413	0.0106519	10.142	317.
0.59311431	0.08328294	0.0278020	47.646	0.0111599	10.243	317.
0.59532559	0.08560266	0.0286282	48.880	0.0116717	10.341	318.
0.59671575	0.08792238	0.0294545	50.113	0.0121873	10.434	319.
0.59849285	0.09024210	0.0302807	51.347	0.0127066	10.523	320.
0.59968154	0.09256182	0.0311070	52.580	0.0132296	10.608	321.
0.60066400	0.09488154	0.0319333	53.814	0.0137563	10.690	322.
0.60180750	0.09720126	0.0327595	55.047	0.0142866	10.767	323.
0.60300292	0.09952098	0.0335858	56.281	0.0148205	10.840	324.
0.60399207	0.10184070	0.0344120	57.514	0.0153580	10.910	325.
0.60471229	0.10416042	0.0352383	58.748	0.0158990	10.975	326.
0.60552464	0.10648014	0.0360646	59.981	0.0164435	11.037	327.
0.60639387	0.10879985	0.0368908	61.215	0.0169915	11.095	328.
0.60713706	0.11111957	0.0377171	62.448	0.0175430	11.149	329.
0.6[illegible]76925	0.11343929	0.0385433	63.682	0.0180978	11.199	329.
0.60841362	0.11575901	0.0393696	64.915	0.0186561	11.245	330.
0.609[illegible]337	0.11807873	0.0401959	66.149	0.0192177	11.287	331.
[illegible]986947	0.12039845	0.0410221	67.382	0.0197826	11.325	332.
[illegible]071484	0.12271817	0.0418484	68.616	0.0203508	11.359	333.
0.61154[illegible]39	0.12503789	0.0426746	69.849	0.0209223	11.389	334.
0.61236465	0.12735761	0.0435009	71.083	0.0214970	11.416	335.
0.61309213	0.12967733	0.0443272	72.316	0.0220748	11.438	336.
0.61371902	0.13199705	0.0451534	73.550	0.0226559	11.457	337.
0.61438613	0.13431677	0.0459797	74.783	0.0232400	11.472	338.
0.61467740	0.13663649	0.0468060	76.017	0.0238273	11.483	339.
0.61518418	0.13895621	0.0476322	77.250	0.0244176	11.490	340.
0.61583573	0.14127593	0.0484585	78.484	0.0250109	11.493	342.
0.61644297	0.14359565	0.0492847	79.717	0.0256072	11.492	343.
0.61700924	0.14591537	0.0501110	80.951	0.0262065	11.488	344.
0.61757552	0.14823509	0.0509373	82.184	0.0268087	11.479	345.
0.61811381	0.15055481	0.0517635	83.418	0.0274138	11.467	346.
0.61865885	0.15287453	0.0525898	84.651	0.0280218	11.451	347.
0.61915041	0.15519425	0.0534160	85.885	0.0286326	11.431	348.
0.61937346	0.15751397	0.0542423	87.118	0.0292463	11.407	349.
0.61986139	0.15983369	0.0550685	88.352	0.0298626	11.380	350.
0.62038510	0.16215341	0.0558948	89.585	0.0304810	11.348	351.
0.62090881	0.16447313	0.0567211	90.8[illegible]	[illegible]0311036	11.313	352.

0.62131243	0.16679285	0.0575473	92.052	0.0317281	11.273	353.
0.62164490	0.16911257	0.0583736	93.286	0.0323553	11.230	354.
0.62197663	0.17143229	0.0591999	94.519	0.0329851	11.184	355.
0.62237753	0.17375201	0.0600261	95.753	0.0336175	11.133	356.
0.62283154	0.17607173	0.0608524	96.986	0.0342524	11.078	357.
0.62353832	0.17839145	0.0616786	98.220	0.0348898	11.020	358.
0.62398404	0.18071117	0.0625049	99.453	0.0355298	10.958	359.
0.62415716	0.18303089	0.0633312	100.687	0.0361722	10.892	360.
0.62449013	0.18535061	0.0641574	101.920	0.0368170	10.822	361.
0.62495665	0.18767033	0.0649837	103.154	0.0374643	10.748	362.
0.62575472	0.18999005	0.0658100	104.387	0.0381139	10.671	363.
0.62652545	0.19230976	0.0666362	105.621	0.0387659	10.590	364.
0.62723722	0.19462948	0.0674625	106.854	0.0394202	10.505	366.
0.62816057	0.19694920	0.0682887	108.088	0.0400768	10.416	367.
0.62938175	0.19926892	0.0691150	109.321	0.0407356	10.323	368.
0.63210199	0.20158864	0.0699413	110.555	0.0413967	10.227	369.
0.63473639	0.20390836	0.0707675	111.788	0.0420600	10.126	370.
0.63829693	0.20622808	0.0715938	113.022	0.0427254	10.023	371.
0.64127860	0.20854780	0.0724200	114.255	0.0433931	9.915	372.
0.64544035	0.21086752	0.0732463	115.489	0.0440628	9.803	373.
0.65088021	0.21318724	0.0740726	116.722	0.0447346	9.688	374.
0.65643428	0.21550696	0.0748988	117.955	0.0454085	9.569	375.
0.66372883	0.21782668	0.0757251	119.189	0.0460845	9.446	376.
0.67796489	0.22014640	0.0765513	120.422	0.0467624	9.319	377.
0.69316835	0.22246612	0.0773776	121.656	0.0474424	9.189	378.
0.70897544	0.22478584	0.0782039	122.889	0.0481243	9.055	379.
0.73014379	0.22710556	0.0790301	124.123	0.0488081	8.917	380.
0.75617194	0.22942528	0.0798564	125.356	0.0494939	8.775	381.
0.81020000	0.23174500	0.0806826	126.590	0.0501826	8.630	382.

U-144 kbar(shot# AV9)

in situ steady wave: sample thickness= 7.64mm
data entries=100

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1 2 von M eq	temp(k)
0.12056243	0.00243563	0.0007067	1.590	0.0000000	0.607	295.
0.14260475	0.00504744	0.0014636	3.297	0.0000000	1.257	296.
0.16736357	0.00765925	0.0022194	5.006	0.0000000	1.905	296.
0.18892340	0.01027107	0.0029742	6.718	0.0000000	2.550	297.
0.20761435	0.01288288	0.0037279	8.432	0.0000000	3.194	297.
0.22316889	0.01549469	0.0044806	10.149	0.0000000	3.837	297.
0.24189260	0.01810650	0.0052378	11.855	0.0000149	4.463	298.
0.26851199	0.02071831	0.0060175	13.512	0.0000932	5.029	298.
0.31062092	0.02333013	0.0068210	15.120	0.0002377	5.534	298.
0.35542332	0.02594194	0.0076483	16.682	0.0004473	5.978	299.
0.40595130	0.02855375	0.0084995	18.200	0.0007213	6.355	299.
0.43126961	0.03116556	0.0093745	19.677	0.0010586	6.695	300.
0.45676545	0.03377737	0.0102734	21.114	0.0014583	6.969	301.
0.46954232	0.03638918	0.0111898	22.524	0.0019047	7.203	301.
0.48051586	0.03900100	0.0121070	23.933	0.0023584	7.430	302.
0.48641039	0.04161281	0.0130242	25.342	0.0028175	7.652	303.
0.49347540	0.04422462	0.0139414	26.750	0.0032820	7.869	304.
0.49715197	0.04683643	0.0148586	28.159	0.0037512	8.081	304.
0.50361715	0.04944824	0.0157758	29.567	0.0042268	8.288	305.
0.50581419	0.05206006	0.0166930	30.976	0.0047071	8.489	306.
0.50945878	0.05467187	0.0176102	32.385	0.0051927	8.686	307.
0.51365283	0.05728368	0.0185274	33.793	0.0056834	8.877	308.
0.51780424	0.05989549	0.0194446	35.202	0.0061793	9.064	309.
0.52145906	0.06250730	0.0203618	36.611	0.0066804	9.246	309.
0.52292284	0.06511911	0.0212790	38.019	0.0071865	9.422	310.
0.52390565	0.06773093	0.0221962	39.428	0.0076978	9.594	311.
0.52499348	0.07034274	0.0231134	40.837	0.0082140	9.761	312.
0.52621911	0.07295455	0.0240306	42.245	0.0087353	9.922	313.
0.52780224	0.07556636	0.0249478	43.654	0.0092616	10.079	314.
0.52880312	0.07817817	0.0258650	45.063	0.0097927	10.231	315.
0.52938192	0.08078998	0.0267822	46.471	0.0103288	10.378	316.
0.53003140	0.08340180	0.0276994	47.880	0.0108698	10.519	317.
0.53068164	0.08601361	0.0286167	49.288	0.0114155	10.656	318.
0.53135385	0.08862542	0.0295339	50.697	0.0119661	10.789	319.
0.53206261	0.09123723	0.0304511	52.106	0.0125214	10.916	320.
0.53321547	0.09384904	0.0313683	53.514	0.0130814	11.038	321.
0.53376733	0.09646086	0.0322855	54.923	0.0136461	11.155	322.
0.53411892	0.09907267	0.0332027	56.332	0.0142154	11.268	323.
0.53453692	0.10168448	0.0341199	57.740	0.0147894	11.375	324.
0.53501356	0.10429629	0.0350371	59.149	0.0153678	11.478	325.
0.53570188	0.10690810	0.0359543	60.558	0.0159508	11.576	326.
0.53661781	0.10951991	0.0368715	61.966	0.0165382	11.669	327.
0.53745817	0.11213173	0.0377887	63.375	0.0171300	11.757	328.
0.53800216	0.11474354	0.0387059	64.783	0.0177263	11.840	329.
0.53841989	0.11735535	0.0396231	66.192	0.0183269	11.918	330.
0.53887396	0.11996716	0.0405403	67.601	0.0189317	11.992	331.
0.53934792	0.12257897	0.0414575	69.009	0.0195408	12.060	332.
0.53986668	0.12519079	0.0423747	70.418	0.0201542	12.124	333.
0.54046578	0.12780260	0.0432919	71.827	0.0207717	12.183	335.
0.54151152	0.13041441	0.0442091	73.235	0.0213933	12.237	336.
0.54259481	0.13302622	0.0451263	74.644	0.0220190	12.287	337.
0.54295315	0.13563803	0.0460435	76.053	0.0226488	12.331	338.
0.54315576	0.13824984	0.0469608	77.461	0.0232825	12.371	339.
0.54335667	0.14086166	0.0478780	78.870	0.0239202	12.406	340.
0.54360149	0.14347347	0.0487952	80.279	0.0245618	12.436	341.
0.54390129	0.14608528	0.0497124	81.687	0.0252072	12.461	343.
0.54423728	0.14869709	0.0506296	83.096	0.0258565	12.482	344.
0.54457914	0.15130890	0.0515468	84.504	0.0265095	12.499	345.
0.54486767	0.15392072	0.0524640	85.913	0.0271663	12.506	346.
0.54507066	0.15653253	0.0533812	87.322	0.0278268	12.515	347.
0.54524896	0.15914434	0.0542984	88.730	0.0284909	12.516	349.
0.54539863	0.16175615	0.0552156	90.139	0.0291586	12.513	350.
0.54565345	0.16436796	0.0561328	91.548	0.0298299	12.505	351.
0.54591516	0.16697977	0.0570500	92.956	0.0305047	12.492	352.
0.54615551	0.16959159	0.0579672	94.365	0.0311829	12.474	354.
0.54637700	0.17220340	0.0588844	95.774	0.0318646	12.452	355.
0.54659172	0.17481521	0.0598016	97.182	0.0325497	12.424	356.
0.54679936	0.17742702	0.0607188	98.591	0.0332381	12.[illegible]	357.
0.54697957	0.18003883	0.0616360	[illegible]	[illegible]	[illegible]	358.
0.54717214	0.18265065	0.0625532	[illegible].408	[illegible]	12.[illegible]	360.
0.54738979	0.18526246	0.0634704	102.817	[illegible]	[illegible]	361.

0.54759550	0.18787427	0.0643876	104.225	0.0360244	12.218	362.
0.54778897	0.19048608	0.0653049	105.634	0.0367290	12.162	363.
0.54799068	0.19309789	0.0662221	107.043	0.0374366	12.102	365.
0.54817833	0.19570970	0.0671393	108.451	0.0381473	12.037	366.
0.54834885	0.19832152	0.0680565	109.860	0.0388609	11.967	367.
0.54863047	0.20093333	0.0689737	111.269	0.0395776	11.893	368.
0.54886188	0.20354514	0.0698909	112.677	0.0402972	11.813	370.
0.54908336	0.20615695	0.0708081	114.086	0.0410197	11.730	371.
0.54941635	0.20876876	0.0717253	115.494	0.0417450	11.641	372.
0.54980619	0.21138058	0.0726425	116.903	0.0424732	11.548	373.
0.55025637	0.21399239	0.0735597	118.312	0.0432041	11.450	374.
0.55087605	0.21660420	0.0744769	119.720	0.0439378	11.347	376.
0.55149432	0.21921601	0.0753941	121.129	0.0446742	11.240	377.
0.55229857	0.22182782	0.0763113	122.538	0.0454133	11.128	378.
0.55308017	0.22443963	0.0772285	123.946	0.0461550	11.012	379.
0.55389417	0.22705145	0.0781457	125.355	0.0468992	10.891	381.
0.55521621	0.22966326	0.0790629	126.764	0.0476461	10.765	382.
0.55676181	0.23227507	0.0799801	128.172	0.0483954	10.634	383.
0.55822307	0.23488688	0.0808973	129.581	0.0491473	10.499	384.
0.55950337	0.23749869	0.0818145	130.990	0.0499015	10.359	385.
0.56192492	0.24011051	0.0827317	132.398	0.0506582	10.215	386.
0.56358611	0.24272232	0.0833490	133.807	0.0514173	10.065	388.
0.56548308	0.24533413	0.0845662	135.215	0.0521787	9.912	389.
0.56817322	0.24794594	0.0854834	136.624	0.0529425	9.753	390.
0.57422755	0.25055775	0.0864006	138.033	0.0537085	9.590	391.
0.58128360	0.25316956	0.0873178	139.441	0.0544767	9.423	392.
0.58865819	0.25578138	0.0882350	140.850	0.0552472	9.251	393.
0.59831594	0.25839319	0.0891522	142.259	0.0560198	9.074	394.
0.62670000	0.26100500	0.0900694	143.667	0.0567946	8.892	396.

V-64 kbar(shot# VAN 2)

in situ steady wave: sample thickness= 5.05mm
data entries= 95

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.82923000	0.00054336	0.0000903	0.199	0.0000000	0.043	296.
0.83132000	0.00329960	0.0005481	1.208	0.0000000	0.258	296.
0.83299000	0.00550450	0.0009139	2.016	0.0000000	0.431	297.
0.83382000	0.00715040	0.0011868	2.619	0.0000000	0.560	297.
0.83505000	0.01043400	0.0017308	3.824	0.0000000	0.817	297.
0.83546000	0.01152900	0.0019121	4.227	0.0000000	0.902	297.
0.83671000	0.01372600	0.0022756	5.034	0.0000000	1.074	297.
0.83796000	0.01538000	0.0025490	5.642	0.0000000	1.203	297.
0.83920000	0.01812000	0.0030017	6.651	0.0000000	1.416	297.
0.84087000	0.02032500	0.0033656	7.463	0.0000000	1.588	298.
0.84295000	0.02362500	0.0039097	8.680	0.0000000	1.845	298.
0.84462000	0.02637300	0.0043624	9.694	0.0000000	2.059	298.
0.84629000	0.02803400	0.0046357	10.308	0.0000000	2.188	298.
0.84755000	0.02968600	0.0049078	10.919	0.0000000	2.317	298.
0.84964000	0.03190100	0.0052716	11.738	0.0000000	2.489	298.
0.85132000	0.03356300	0.0055446	12.353	0.0000000	2.618	298.
0.85299000	0.03522400	0.0058173	12.968	0.0000000	2.747	298.
0.85593000	0.03799600	0.0062720	13.996	0.0000000	2.962	299.
0.85802000	0.04020900	0.0066347	14.817	0.0000000	3.133	299.
0.86096000	0.04243800	0.0069997	15.644	0.0000000	3.306	299.
0.86434000	0.04358700	0.0071878	16.071	0.0000000	3.395	299.
0.86728000	0.04581600	0.0075524	16.899	0.0000000	3.567	299.
0.86980000	0.04803700	0.0079154	17.726	0.0000000	3.739	299.
0.87317000	0.04918600	0.0081031	18.153	0.0000000	3.828	299.
0.87739000	0.05089500	0.0083852	18.783	0.0000151	3.951	300.
0.88076000	0.05258800	0.0086705	19.394	0.0000594	4.055	300.
0.88329000	0.05372200	0.0088649	19.796	0.0001052	4.115	300.
0.88793000	0.05598200	0.0092602	20.582	0.0002345	4.213	300.
0.89089000	0.05658100	0.0093667	20.786	0.0002772	4.234	300.
0.89510000	0.05829000	0.0096746	21.363	0.0004179	4.282	300.
0.89890000	0.05999100	0.0099869	21.926	0.0005857	4.314	300.
0.90269000	0.06169200	0.0103052	22.479	0.0007806	4.330	301.
0.90522000	0.06336900	0.0106218	23.019	0.0009866	4.337	301.
0.90859000	0.06506200	0.0109415	23.564	0.0011956	4.344	301.
0.91026000	0.06672400	0.0112554	24.099	0.0014019	4.350	301.
0.91237000	0.06785000	0.0114680	24.462	0.0015422	4.353	301.
0.91405000	0.06951100	0.0117817	24.997	0.0017501	4.358	301.
0.91699000	0.07119600	0.0120999	25.539	0.0019620	4.362	302.
0.92079000	0.07289700	0.0124211	26.087	0.0021770	4.366	302.
0.92373000	0.07512600	0.0128420	26.805	0.0024604	4.369	302.
0.92583000	0.07625200	0.0130546	27.167	0.0026042	4.371	302.
0.93087000	0.08015000	0.0137907	28.422	0.0031058	4.373	303.
0.93297000	0.08236300	0.0142086	29.135	0.0033930	4.375	303.
0.93548000	0.08512700	0.0147305	30.025	0.0037543	4.371	303.
0.93883000	0.08845000	0.0153580	31.095	0.0041924	4.366	304.
0.94175000	0.09230900	0.0160867	32.337	0.0047061	4.357	304.
0.94426000	0.09561600	0.0167112	33.402	0.0051507	4.346	304.
0.94550000	0.09781300	0.0171261	34.110	0.0054482	4.338	305.
0.94843000	0.10167000	0.0178544	35.351	0.0059748	4.320	305.
0.95092000	0.10607000	0.0186853	36.768	0.0065819	4.295	306.
0.95300000	0.10991000	0.0194104	38.005	0.0071175	4.270	306.
0.95506000	0.11430000	0.0202394	39.418	0.0077361	4.237	307.
0.95630000	0.11758000	0.0208588	40.474	0.0082027	4.209	307.
0.95795000	0.12141000	0.0215821	41.707	0.0087523	4.173	307.
0.95918000	0.12470000	0.0222033	42.767	0.0092285	4.140	308.
0.96084000	0.12799000	0.0228246	43.826	0.0097084	4.103	308.
0.96208000	0.13127000	0.0234440	44.882	0.0101906	4.065	309.
0.96414000	0.13620000	0.0243749	46.469	0.0109222	4.002	309.
0.96580000	0.13949000	0.0249962	47.529	0.0114151	3.957	309.
0.96745000	0.14333000	0.0257213	48.765	0.0119949	3.901	310.
0.96952000	0.14717000	0.0264465	50.002	0.0125797	3.841	310.
0.97202000	0.15102000	0.0271735	51.241	0.0131710	3.778	311.
0.97367000	0.15486000	0.0278986	52.478	0.0137656	3.712	311.
0.97534000	0.15761000	0.0284179	53.363	0.0141944	3.662	312.
0.97701000	0.15981000	0.0288333	54.071	0.0145392	3.621	312.
0.97952000	0.16258000	0.0293564	54.963	0.0149757	3.568	312.
0.98246000	0.16480000	0.0297756	55.678	0.0153272	3.524	312.
0.98497000	0.16757000	0.0302987	56.570	0.0157681	3.467	313.
0.98791000	0.16980000	0.0307198	57.288	0.0161248	3.420	313.
0.99170000	0.17204000	0.0311428	58.009	0.0164848	3.372	313.
0.99422000	0.17426000	0.0315620	58.724	0.0168431	3.323	313.

0.99800000	0.17705000	0.0320889	59.622	0.0172956	3.260	314.
1.00140000	0.17874000	0.0324080	60.166	0.0175709	3.221	314.
1.00430000	0.18043000	0.0327271	60.711	0.0178470	3.181	314.
1.00730000	0.18103000	0.0328404	60.904	0.0179453	3.167	314.
1.01190000	0.18220000	0.0330614	61.280	0.0181373	3.138	314.
1.01610000	0.18337000	0.0332823	61.657	0.0183296	3.110	315.
1.01950000	0.18343000	0.0332936	61.677	0.0183395	3.108	315.
1.02550000	0.18408000	0.0334164	61.886	0.0184466	3.093	315.
1.02930000	0.18470000	0.0335335	62.085	0.0185489	3.077	315.
1.03560000	0.18590000	0.0337601	62.472	0.0187471	3.047	315.
1.04110000	0.18600000	0.0337789	62.504	0.0187637	3.045	315.
1.04700000	0.18720000	0.0340055	62.890	0.0189624	3.015	315.
1.05040000	0.18726000	0.0340169	62.910	0.0189723	3.013	315.
1.05510000	0.18735000	0.0340339	62.939	0.0189873	3.011	315.
1.05850000	0.18741000	0.0340452	62.958	0.0189972	3.009	315.
1.06400000	0.18752000	0.0340660	62.993	0.0190155	3.006	315.
1.06910000	0.18815000	0.0341849	63.196	0.0191200	2.990	315.
1.07410000	0.18825000	0.0342038	63.228	0.0191367	2.988	315.
1.08260000	0.18895000	0.0343360	63.454	0.0192530	2.970	315.
1.08810000	0.19014000	0.0345607	63.837	0.0194512	2.939	315.
1.09490000	0.19026000	0.0345834	63.876	0.0194712	2.936	315.
1.10120000	0.19038000	0.0346060	63.914	0.0194912	2.933	315.
1.10720000	0.19104000	0.0347307	64.127	0.0196013	2.915	315.
1.11440000	0.19171000	0.0348572	64.343	0.0197133	2.898	315.

V-97 kbar(shot# VAN 3)

in situ steady wave: sample thickness= 5.05mm
data entries= 93

time(us)	p vel(mm/us)	e=1-ro/r compression	sigma(kbar) normal stress	psi plastic strain von Mises eq	tau(kbar) deviatoric stress 1/2 von M eq	temp(k)
0.82884000	0.00060239	0.0001001	0.220	0.0000000	0.047	296.
0.83009000	0.00225900	0.0003753	0.827	0.0000000	0.177	296.
0.83260000	0.00502880	0.0008350	1.841	0.0000000	0.394	297.
0.83426000	0.00832420	0.0013814	3.050	0.0000000	0.652	297.
0.83550000	0.01106700	0.0018356	4.057	0.0000000	0.866	297.
0.83716000	0.01382000	0.0022911	5.069	0.0000000	1.081	297.
0.83840000	0.01656300	0.0027445	6.078	0.0000000	1.295	297.
0.83963000	0.01930600	0.0031975	7.088	0.0000000	1.509	298.
0.84130000	0.02151500	0.0035619	7.902	0.0000000	1.681	298.
0.84464000	0.02593200	0.0042898	9.531	0.0000000	2.025	298.
0.84630000	0.02868500	0.0047428	10.548	0.0000000	2.239	298.
0.84881000	0.03199800	0.0052875	11.774	0.0000000	2.496	298.
0.85090000	0.03421500	0.0056516	12.594	0.0000000	2.668	299.
0.85342000	0.03644200	0.0060171	13.419	0.0000000	2.841	299.
0.85719000	0.03978200	0.0065647	14.658	0.0000000	3.100	299.
0.85929000	0.04145600	0.0068389	15.279	0.0000000	3.230	299.
0.86182000	0.04313900	0.0071145	15.904	0.0000000	3.360	299.
0.86476000	0.04483100	0.0073913	16.533	0.0000000	3.491	299.
0.86771000	0.04652300	0.0076680	17.162	0.0000000	3.622	299.
0.87065000	0.04875800	0.0080332	17.994	0.0000000	3.795	299.
0.87487000	0.05047700	0.0083139	18.634	0.0000000	3.928	300.
0.87910000	0.05219600	0.0085970	19.269	0.0000124	4.053	300.
0.88204000	0.05386800	0.0088804	19.883	0.0000488	4.162	300.
0.88500000	0.05503600	..0090753	20.294	0.0000870	4.228	300.
0.88752000	0.05671900	0.0093651	20.888	0.0001624	4.313	300.
0.89005000	0.05785900	0.0095640	21.286	0.0002265	4.362	300.
0.89215000	0.05953400	0.0098602	21.862	0.0003396	4.424	300.
0.89426000	0.06066400	0.0100626	22.245	0.0004285	4.459	300.
0.39637000	0.06179500	0.0102673	22.625	0.00052[illegible]5	4.487	301.
0.89889000	0.06347900	0.0105760	23.184	0.0006934	4.519	301.
0.90057000	0.06460100	0.0107843	23.551	0.0008161	4.532	301.
0.90267000	0.06627500	0.0110966	24.097	0.0010069	4.548	301.
0.90562000	0.06851000	0.0115136	24.825	0.0012633	4.569	301.
0.90772000	0.07018500	0.0118261	25.371	0.0014567	4.583	301.
0.91021000	0.07404100	0.0125455	26.627	0.0019058	4.614	302.
0.91186000	0.07788000	0.0132618	27.879	0.0023584	4.641	302.
0.91350000	0.08226200	0.0140793	29.307	0.0028816	4.668	303.
0.91516000	0.08555700	0.0146940	30.381	0.0032797	4.685	303.
0.91639000	0.08820100	0.0152060	31.275	0.0036143	4.697	303.
0.91845000	0.09323500	0.0161265	32.883	0.0042227	4.714	304.
0.91968000	0.09706500	0.0168410	34.131	0.0047011	4.724	304.
0.92089000	0.10198000	0.0177580	35.733	0.0053228	4.731	305.
0.92208000	0.10798000	0.0188774	37.688	0.0060934	4.732	306.
0.92329000	0.11344000	0.0198961	39.467	0.0068058	4.726	306.
0.92405000	0.11998000	0.0211162	41.599	0.0076730	4.709	307.
0.92568000	0.12545000	0.0221368	43.381	0.0084099	4.687	308.
0.92648000	0.12927000	0.0228494	44.626	0.0089306	4.669	308.
0.92808000	0.13691000	0.0242748	47.116	0.0099873	4.618	309.
0.92846000	0.14073000	0.0249875	48.361	0.0105231	4.589	310.
0.92962000	0.14890000	0.0265118	51.024	0.0116857	4.514	311.
0.93042000	0.15327000	0.0273271	52.448	0.0123168	4.467	311.
0.93118000	0.15981000	0.0285472	54.579	0.0132732	4.389	312.
0.93236000	0.16744000	0.0299707	57.066	0.0144068	4.286	313.
0.93310000	0.17561000	0.0314950	59.728	0.0156416	4.160	314.
0.93427000	0.18378000	0.0330192	62.391	0.0168980	4.019	315.
0.93502000	0.19195000	0.0345435	65.053	0.0181755	3.862	316.
0.93579000	0.19795000	0.0356629	67.009	0.0191270	3.727	316.
0.93654000	0.20557000	0.0370845	69.492	0.0203515	3.567	317.
0.93731000	0.21156000	0.0382021	71.444	0.0213265	3.42[illegible]	318.
0.93851000	0.21757000	0.0393233	73.403	0.0223156	3.271	319.
0.93929000	0.22302000	0.0403401	75.179	0.0232218	3.126	319.
0.93966000	0.227[illegible]000	0.0411517	76.597	0.0239514	3.006	320.
0.94083000	0.23501000	0.0425771	79.087	0.0252462	2.783	321.
0.94[illegible]0000	0.24482000	0.0444073	82.284	0.0269333	2.479	322.
0.94404000	0.24975000	0.0453271	83.890	0.0277911	2.317	322.
0.94525000	0.25466000	0.0462431	85.490	0.0286528	2.151	323.
0.94649000	0.25741000	0.0467562	86.387	0.0291382	2.056	323.
0.94[illegible]58000	0.25963000	0.0471703	87.110	0.0295315	1.978	323.
0.94942000	0.26019000	0.0472748	87.293	0.0296309	1.958	323.
0.95067000	0.26184000	0.0475827	87.830	0.0299244	1.899	323.
0.95192000	0.26404000	0.0479931	88.547	0.0303168	1.81[illegible]	324.

0.95359000	0.26571000	0.0483047	89.092	0.0306156	1.758	324.
0.95526000	0.26792000	0.0487170	89.812	0.0310121	1.676	324.
0.95903000	0.27180000	0.0494409	91.076	0.0317114	1.529	324.
0.96196000	0.27458000	0.0499595	91.982	0.0322150	1.422	325.
0.96406000	0.27625000	0.0502711	92.526	0.0325184	1.357	325.
0.96616000	0.27793000	0.0505845	93.074	0.0328244	1.290	325.
0.97038000	0.28019000	0.0510062	93.810	0.0332373	1.200	325.
0.97461000	0.28136000	0.0512244	94.192	0.0334515	1.153	325.
0.98010000	0.28311000	0.0515509	94.762	0.0337726	1.082	325.
0.98433000	0.28374000	0.0516685	94.967	0.0338884	1.057	325.
0.98899000	0.28438000	0.0517879	95.176	0.0340062	1.030	325.
0.99619000	0.28562000	0.0520192	95.580	0.0342346	0.979	326.
1.00380000	0.28687000	0.0522524	95.987	0.034465	0.928	326.
1.01060000	0.28755000	0.0523793	96.[illegible]09	0.0345909	0.899	326.
1.01780000	0.28824000	0.0525080	96.434	0.0347185	0.870	326.
1.02670000	0.28897000	0.0526442	96.672	0.0348537	0.840	326.
1.03390000	0.28967000	0.0527748	96.900	0.0349834	0.810	326.
1.04450000	0.28989000	0.0528159	96.972	0.0350242	0.801	326.
1.05130000	0.29003000	0.0528420	97.017	0.0350502	0.795	326.
1.05680000	0.29015000	0.0528644	97.056	0.0350724	0.790	326.
1.06360000	0.29029000	0.0528905	97.102	0.0350984	0.784	326.
1.07760000	0.29058000	0.0529446	97.197	0.0351522	0.772	326.