Tertiary boundary, which has been attributed to a major impact event. The strong evidence for an impact origin of the Bunyeroo ejecta also points to a cosmic source for its PGE signature.

The shales above and below the Bunyeroo ejecta horizon also show Ir and Pt enrichments (0.073–0.45 ppb Ir, 3.1–313 ppb Pt), suggesting postdepositional mobilization of Ir and Pt. Interelement ratios of the PGEs within the ejecta horizon from different sites are also quite variable, again suggesting postdepositional, low-temperature mobilization of these elements. Indeed, all green shale horizons in the Bunyeroo Formation that were analyzed, regardless of their stratigraphic position, have relatively high levels of Ir and other PGEs. The diagenetic origin of these anomalies is indicated by their association with enrichments in Cu-V-Zn-Co-Ni in thin, permeable green-colored reduced beds in a predominantly red bed sequence. A redox precipitation model similar to that invoked for red bed Cu-U-V deposits has been proposed to explain the PGE anomalies in the green shales [5].

In summary, the Bunyeroo ejecta is unique as the only known example of a widely dispersed, coarse-grained ejecta blanket that is, moreover, strongly linked to a known major impact structure. The marked Ir-PGE anomalies in the ejecta horizon provide support for the hypothesis that meteorite impact events can produce Ir anomalies in terrestrial sediments. The findings also indicate that Ir can be mobilized and concentrated in sediments by low-temperature diagenetic processes. The identification of ejecta horizons in sedimentary rocks therefore should be based on the coincidence of shock-metamorphic features in the detritus and clear Ir anomalies.

References: [1] Compston W. et al. (1987) *Aust. J. Earth Sciences, 34*, 435–445. [2] Gostin V. A. et al. (1986) *Science, 233*, 189–200. [3] Gostin V. A. et al. (1989) *Nature, 340*, 542–544. [4] Wallace M. W. et al. (1989) *Aust. J. Earth Sciences, 36*, 585–587. [5] Wallace M. W. et al. (1990) *Geology, 18*, 132–135. [6] Wallace M. W. et al. (1990) *Meteoritics, 25*, 161–165. [7] Wallace M. W. et al. (1990) *Mines and Energy Review, South Australia, 157*, 29–35. [8] Williams G. E. (1986) *Science, 233*, 200–203. [9] Williams G. E. (1987) *Search, 18*, 143–145.

OPTICAL AND TEM STUDY OF SHOCK METAMORPHISM FROM THE SEDAN TEST SITE. A. J. Gratz, Lawrence Livermore National Laboratory, Livermore CA 94550, USA.

Thus far, detailed petrologic studies of shock metamorphism have been performed on samples recovered from laboratory experiments and on a few natural impactites. The loading history of these samples is quite different: In particular, laboratory experiments spend only a short time (<1 μs) at peak pressure, whereas natural impactites may have stress pulses from 0.1–1 ms. On the other hand, laboratory experiments have known stress histories; natural impactites do not. Natural samples are also subjected to thousands or millions of years of postshock annealing and/or weathering. A useful intermediate case is that of nuclear detonation. Stress pulses for these events can reach 0.1 ms or higher, and samples are obtained in pristine condition. All three types of loading produce stresses of hundreds of kilobars.

Samples studied were taken from the Sedan nuclear test site, and consist of a coarse-grained granodiorite containing quartz, K-feldspar, cordierite, and hornblende. Samples were studied optically in thin section, then were thinned with an ion mill and studied by transmission electron microscopy (TEM).

Optically, quartz and K-feldspar displayed numerous sets of planar deformation features (PDFs) identical to the nondecorated PDFs seen in laboratory samples and many natural impactites. Other minerals showed less distinct shock damage, with some fracturing visible in cordierite and hornblende.

TEM study showed that the PDFs in quartz and feldspar corresponded to densely packed wide transformation lamellae identical to those described in laboratory studies. The transformation lamellae in both minerals were amorphous, with no sign of high-pressure phases. In the case of K-feldspar only, narrow sublamellae extended outward from some wide lamellae. Quartz, which was more abundant and studied more extensively, contained no shock-induced dislocations. Some planar features were also seen in cordierite, but could not be identified due to rapid beam damage. No shock defects were seen in hornblende in TEM.

The shock-induced defects present at the Sedan site are very similar to those seen in shock recovery experiments, and also to those present at certain natural events (e.g., Meteor Crater). This suggests that shock deformation in quartz is not strongly dependent on shock pulse duration, and that laboratory recovery experiments are useful simulations of natural impact events. The lack of evidence for high-pressure phases along transformation lamellae is in agreement with past studies, and supports the idea that direct, solid-state amorphization occurs along transformation lamellae. Finally, no evidence was seen for decorated PDFs. Presumably decoration is due to postshock annealing or weathering. Further work should focus on processes that lead to decoration of transformation lamellae.

SIMULATED METEORITE IMPACTS AND VOLCANIC EXPLOSIONS: EJECTA ANALYSES AND PLANETARY IMPLICATIONS. A. J. Gratz and W. J. Nellis, Lawrence Livermore National Laboratory, Livermore CA 94550, USA.

Past cratering studies have focused primarily on crater morphology. However, important questions remain about the nature of crater deposits. Phenomena that need to be studied include the distribution of shock effects in crater deposits and crater walls; the origin of mono- and polymict breccias; differences between local and distal ejecta; deformation induced by explosive volcanism; and the production of unshocked, high-speed ejecta that could form the lunar and martian meteorites found on the Earth. To study these phenomena, one must characterize ejecta and crater wall materials from impacts produced under controlled conditions.

New efforts at LLNL simulate impacts and volcanism and study resultant deformation. All experiments use the two-stage light-gas gun facility at LLNL to accelerate projectiles to velocities of 0.2 to 4.3 km/s, inducing shock pressures of 0.9 to 50 GPa. We use granite targets and novel experimental geometries to unravel cratering processes in crystalline rocks.

We have thus far conducted three types of simulations: soft recovery of ejecta, "frozen crater" experiments, and an "artificial volcano." In the first case, a projectile impacts a granite disk, jetting ejecta, which is gently recovered in a soft-foam fixture to minimize postejection deformation. In "frozen crater" experiments, a granite block is snugly embedded in a large Al block with a narrow entry tunnel for the projectile. The projectile, which deforms on impact, seals most of the ejecta in place, minimizing postimpact material movement and allowing study of the shocked material close to its