SHOCK DEFORMATION TEXTURE OF OLIVINE CRYSTALS OF THE EETA79001 SHERGOTTITE

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All the shergottite meteorites display intense shock metamorphisms. Especially, plagioclase shows a characteristic shock feature: formation of diaplectic glass (maskelynite) or melting (Duke, 1968; McSween and Stöffler, 1980; McSween and Jarosewich, 1983). By studying the shergottite meteorites, we can get a better understanding of the nature of shock metamorphism of olivine, in comparison with that of coexisting plagioclase which is the most sensitive and well-characterized pressure indicator, in natural impact events. Olivine occurs in two shergottites, ALHA77005 and EETA79001. Previously we reported shock deformation microstructures of olivine crystals in the ALHA77005 shergottite (Mori and Takeda, 1983).

Transmission electron microscopic (TEM) study was conducted to elucidate the shock deformation microstructure of olivine in the EETA79001 shergottite. One olivine megacryst was separated from the chip of EETA79001. The olivine crystal was examined on an X-ray precession camera to determine the crystallographic orientation and the diffraction asterism. Sample preparation for TeM study was performed using a conventional ion-thinning technique after X-ray study. Optically, the olivine shows irregular fractures and undulatory extinction. TEM observation reveals deformation microstructures characteristic of shock (i.e. dislocation, crack) are very common in the olivine. Long straight [001] screw dislocations are predominant. Some dislocations form dipole configurations. Ashworth and Barber (1975) observed similar dislocation substructures of olivine in the Olivenza and Hedjaz chondrites. Dislocation densities are ca. 10^8 - 10^{10} cm^{-2} in EETA79001. Zones of very high dislocation density occur in association with microcracks. In some cases, small amounts of amorphous zone are observed along the microcracks. Such an amorphous zone may represent a diaplectic glass produced by shock compression (Jeanloz *et al.*, 1979). Shock-induced thermal effect is apparently negligible in EETA79001, judging from the small degree of dislocation recovery and the preservation of the diaplectic glass.

McSween and Jarosewich (1983) estimated peak shock pressures of 35-45 GPa experienced by EETA79001. Their estimate is based on the following diagnostic observations: mosaicism and granulation in olivine, formation of maskelynite, and production of melt pockets and veins. As far as our observation on the deformation microstructures of olivine is concerned, lower shock pressures (ca. 20-30 GPa) are inferred than those of McSween and Jarosewich (1983). This may reflect a heterogeneous distribution of shock deformation or a refractory nature of olivine for shock deformation.

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ACTINIDE CHEMISTRY OF ALLENDE COMPONENTS

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U and Th in inclusions. Previous reports of high Th/U in Allende Ca,Al-rich inclusions (Boynton, 1978; Chen and Wasserburg, 1981; Stapanian, 1981) may indicate that U was not acting as a refractory element. The apparent ease of Th/U fractionation in the earliest material makes the ubiquity of Th/U = 3.8 in the solar system hard to understand. U-Th fission track radiography offers the possibility of a better understanding of actinide chemistry in Allende Ca,Al-rich inclusions. Volatility and valence differences between Th and U make these elements potentially useful in distinguishing between primary (condensation?) characteristics and those produced later by alteration. A preliminary examination of TS-23 (a type B inclusion provided by L. Grossman, 1975) shows U to be highly enriched in the inclusion rim. This result is qualitatively similar to that found for U and Th in type A inclusions by Stapanian (1981). The rim sequence in TS-23 consists of layers of (moving inwards): olivine, aluminous diopside + Ti,Al-rich clinopyroxene, nepheline, and Fe-rich spinel + perovskite. U is enriched in two of these layers. The band containing the Ti,Al-rich clinopyroxene is about 5-10 μm thick and contains U at the 1 ppm level. The distribution of U in this band is fairly uniform but submicron U-rich phases (perovskite?) cannot be ruled out as the source of tracks at this time. The Fe-rich spinel layer is also high in U due to perovskite grains which contain $\geqslant$ 3 ppm U. Away from the rim, the major phases are fassaite, melilite, and anorthite which contain 40, 60, and $\leqslant$ 20 ppb U, respectively. For U to be enriched by 17$\times$ C1 values (Grossman *et al.*, 1977), the majority of the U must lie in the rim. However, U enrichments are also observed along some grain boundaries, within fractures, and as $\lesssim$ 10 μm hot spots within fine grained interstitial phases (Cl-rich in many cases). The extent to which these enrichments as well as those in the rims represent alteration may become apparent in our upcoming Th measurements in this and other inclusions.

Pu in chondrules. Mesostasis in chondrules from ordinary unequilibrated chondrites show enrichments in U and REE but no evidence for ^{244}Pu which instead appears to be concentrated in Ca-phosphates (Murrell and Burnett, 1983). This indicates either an initial Pu-REE, U fractionation or early migration of Pu from chondrules into phosphates. Neither of these alternatives are easy to explain. ^{244}Pu-Xe excesses have been measured in some Allende chondrules (Swindle *et al.*, 1983) and U enrichments are observed by us in mesostasis from some Allende chondrules. We have etched Allende chondrules to reveal fission tracks in olivine from ^{244}Pu in adjacent mesostasis, see Murrell and Burnett (1983). Reconnaissance examination of twenty chondrules showed a definite excess of tracks in olivine-mesostasis contacts in one chondrule (^{244}Pu content of ~ 0.4 ppb at the time of track retention); three other chondrules gave only a marginal indication of tracks originating from mesostasis, and the rest gave no indication. Therefore, we tentatively conclude that, in at least one chondrule, ^{244}Pu was present initially in mesostasis. The compatibility of our results with the fission Xe data (Swindle *et al.*, 1983) is unclear at present.

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THE LOW-ENERGY SECONDARY COSMIC RAY FLUX: DETECTORS, IN IRON METEORITES

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The cosmic ray produced nuclides in the interiors of very large bodies are mainly due to secondary particle reactions. The records of low-energy products, specifically the neutron capture products in meteorites, may provide new information regarding multi-stage irradiation and parent body break-ups. Such multi-stage histories have recently been inferred for some irons (Marti *et al.*, 1984): In addition, the nuclide pair ^{129}I - ^{129}Xe, produced chiefly through neutron capture ^{128}Te(n,γ,β)^{129}I $\rightarrow$ ^{129}Xe, may serve as a new chronometer, which for single exposures is independent of shielding and production rates. The half-life of ^{129}I (1.57 $\times$ 10^{7}y) falls into the existing gap between those of ^{53}Mn and ^{40}K, and is well suited to provide exposure age information for the 10^7 to 3 $\times$ 10^{8}y interval. The study of a suitable set of nuclides should make it possible to obtain the energy spectrum of cosmic rays. Noble gas nuclides, in general, are the best candidates for these investigations. The troilite nodules of iron meteorites contain very low amounts of trapped gas and, because of their elemental abundance systematics of suitable target elements for low energy production of noble gas nuclides, they are ideal candidates for this purpose (Kirsten, 1973; Hagg and Kirsten, 1975). We present results of a study of noble gases and nitrogen in a troilite nodule of the Cape York iron.