PYROXENE CHEMICAL VARIATIONS OF HEAVILY SHOCKED UREILITES AND THE PLANETESIMAL-SCALE COLLISION MODEL FOR THE UREILITE GENESIS.

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Among the recently proposed ureilite formation models (1-4), chemical constraints for the ureilite formation have been explained by a model calculation by Goodrich et al. (4). The cumulate model proposed early planetary scale differentiation to remove plagioclase components enriched by Eu. Discovery of oxygen isotope anomaly and heterogeneity in ureilites by Clayton and Mayeda (3) made it difficult to think that such large scale melting preserves oxygen isotope anomaly in the source material. In order to preserve oxygen isotope anomaly, localized heat sources with short duration by impact processes are preferable. The planetesimal collision model (2) can explain the anticorrelation of MnO/FeO. We investigated mineralogy of very heavily shocked small ureilites recently found in Antarctica to understand the collisional processes. The results were interpreted on the basis of experiments by Arakawa et al. (5), and by Tsukahara and Yamazaki (6), and REE patterns of shock melted and recrystallized diogenites (7).

LEW86216 is very small (8) and the polished thin section (PTS) may not be representative. It is heavily shocked, the olivines being converted into a mosaic of tiny grains (ave. 0.05 mm) (8). Microprobe analyses show pyroxene compositions are variable (Fig. 1). Carbon and metal-sulfide veins are disrupted and we cannot recognize the original grain boundaries. Y74154,51-1 is also heavily shocked and the olivine crystals are converted into aggregates of fine crystals and shows granoblastic textures. A part of carbonaceous veins, metal-sulfide veins are disappeared by shock vaporization and are discontinuous, so that the original grain boundaries of olivine are not clear. Pigeonite crystals still keep their crystal morphology, and show a slight cloudy appearance and are spotted by dust-like stains. The chemical trends of pigeonites are scattered at the Mg-rich corner of the pyroxene quadrilateral towards the enstatite corner (Fig. 1).

Y791839,52-2 has been described as a shock melted ureilite (9). A part of the melted portion may be a thick fusion crust, but also shock altered portions are present. Along the grain boundaries at the rims, the olivine crystals are partly disturbed and fine-grained dusty portions are produced. This ureilite is the most Fe-rich ureilite with Fa close to 25. The pyroxene crystals are small and are finely fractured. Olivine crystals are elongated along one direction and stack together with common crystallographic orientation. This texture is more close to experimentally reproduced texture by partial melting and growth with temperature gradient (6) than to cumulate texture (1).

Gravitational separation of early grown or produced refractory magnesian silicates towards the midplane of the nebula (2) may explain dark inclusions of CV3 chondrites enriched in ureilite components (3). Shock recrystallized diogenites (e.g. Y74013, Y74037) with textures similar to LEW86216 have ureilite-like V shaped chondrite normalized REE patterns with Eu depletion and portion of REE and Eu are enriched in recrystallized portions (7). Plagioclase and silica were crystallized, because of the absence of carbons and channels to expel the residual melts. Shock experiments by Arakawa et al. (5) of mixtures of olivine, Ni and carbon show the preferential melting of the olivine rims at grain boundaries and production of clean olivine crystals. The shock altered ureilites show disturbance at the grain boundaries. Chemical variations of pyroxenes (Fig. 1) are similar to those of the entire trends shown by all ureilites taken together and Y790981. When crystal growth proceeds with little melts with local temperature gradients, a process similar to temperature gradient zone refining will take place, and incompatible elements will be accumulated. The influence of volatiles in the carbonaceous chondrites for ureilite genesis has to be taken into account. The absence of carbon veins in some part of the Y74154 suggests that some volatile components will be vaporized. If the size of the planet is small, these components will be brought to the surface and be lost in space, explaining the scarcity of plagioclase in ureilites. It is known that mixtures of sands and water will expel water by intense earthquake. A similar phenomena may take place by planetesimal-scale collision.

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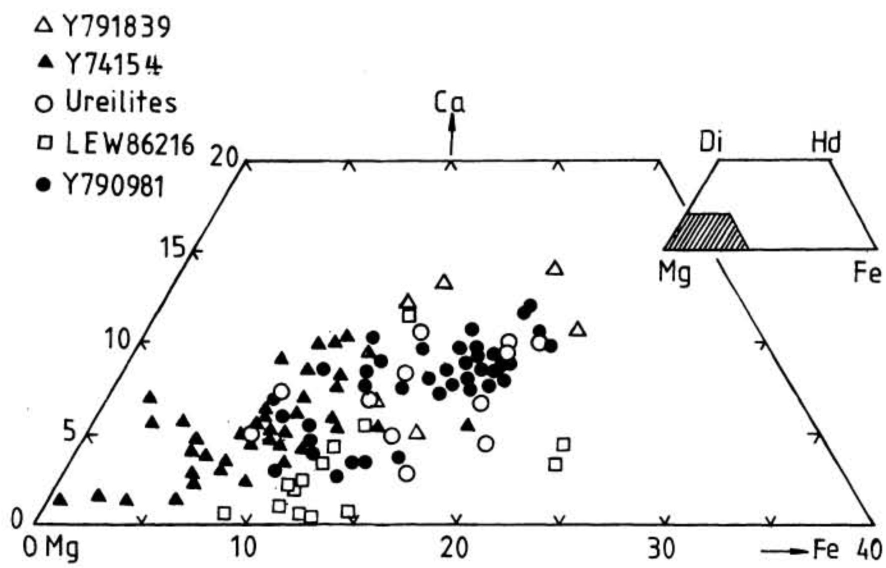

Fig. 1. A part of pyroxene quadrilateral of shocked ureilites. Chemical variations are due to incomplete resolution of microprobe for mixtures of shock produced glass, augite and enstatite.