PETROGENESIS OF FE,SI-METALS IN BRECCIATED UREILITES.

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Introduction: Ureilites are carbon-bearing ultramafic achondrites, the majority of which are unbrecciated and thought to represent samples of asteroidal mantle [***e.g.***1,2]. Approximately 15% of ureilites are polymict or dimict fragmental breccias. In these, Fe,Ni-metal containing >8 atm% Si, primarily suessite and occasional hapkeite (hereafter collectively referred to as Fe,Si-metal), have been identified [3,4,5,6].

Petrography: Fe,Si-metal is observed in three distinct petrographic occurrences. Type I: "lithology B" of dimict breccia NWA 1241 [7,5](and perhaps North Haig [3]) contains abundant coarse interstitial suessite of relatively uniform composition. Type II: [6] observed metals with a range of Si up to 31 atm% in shock melt veins of paired dimict ureilites FRO 90168/90228/93008 together with kamacite, phosphides, and troilite. Type III: polymict ureilites EET 83309, EET 87720, and DAG 999/1000/1023 (paired) contain metals with a range of Si up to 38 atm% as isolated clasts or adhering to mineral or lithic fragments that coexist with unrelated metals and sulfides [4]. The homogeneity and abundance of Fe,Si-metal in Type I suggests proximity to site of production. Type II is a disequilibrium assemblage wherein Fe-Si-metals were either stabilized locally at μm scales or else transported with shock melts [6]. Type III Fe,Si-metals were gardened from their original site of production and re-deposited in regolith breccias.

Petrogenesis: The texture of NWA 1241 and trace element compositions of Fe,Si-metals indicate they are indigenous to the ureilite parent body [4]. Fe,Si-metals cannot be in equilibrium with FeO-bearing silicates, so the process that produced them is clearly of short duration and likely impact-related. By contrast, Fe,Si-metals in enstatite chondrites condensed directly from reduced nebula. Fe,Si-metals in lunar breccia Dhofar 280 formed by either reduction by solar wind or condensation from vapor [8]. Surprisingly, Fe,Si-metals have not been reported from unbrecciated ureilites, suggesting that their genesis is restricted to fragmented portions of the parent body. If formed by gas-producing reaction with graphite ($SiO_2 + C \rightarrow Si^0 + CO_x$), sufficiently low fO_2 (buffered by $CO_2 + C \rightarrow 2CO$) could only be realized at pressures approaching zero [9,10], much lower than the capping pressures for reduction of FeO by carbon at equivalent or higher temperatures [9,11,12]. This combination of high-T and low-P in a CO atmosphere is perhaps only realized in the near-surface of a carbon-rich parent body during or shortly after impact, and perhaps only experienced by detached stones.

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