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A Partial Melting Study of an Ordinary Chondrite Composition with Application to the Felsic Asteroidal Crust Formation

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Melting experiments of a synthesized, alkali-bearing, H-chondrite composition were conducted at ambient pressure with three distinct oxygen fugacity conditions (IW-1, IW and IW+2). Oxygen fugacity conditions significantly influence the compositions of partial melts. Partial melts at IW-1 are distinctly enriched in SiO2 relative to those of IW and IW+2 melts. The silica-enriched, reduced (IW-1) melts are characterized by high alkali contents and have silica-oversaturated compositions. In contrast, the silica-depleted, oxidized (?IW) melts, which are also enriched in alkali contents, have distinctly silica-undersaturated compositions. These experimental results suggest that alkali-rich, felsic, asteroidal crusts as represented by paired achondrites Graves Nunataks 06128 and 06129 should originate from a low-degree, relatively reduced partial melt from a parent body having near-chondritic compositions. Based on recent chronological constraints and numerical considerations as well as our experimental results, we propose that such felsic magmatism should have occurred in a parent body that is smaller in size and commenced accreting later than those highly differentiated asteroids having basaltic crusts and metallic cores.

Figure caption:
Summary of magmatic conditions of achondrite suites in terms of degree of melting and fO2 (relative to IW). See [1] for details.

Reference:
[1] Usui, T., Jones, J. H., Mittlefehldt, D. W. A partial melting study of an ordinary (H) chondrite composition with application to the unique achondrite Graves Nunataks 06128 and 06129. Meteoritics and Planetary Sciences, in press.

Keywords: asteroid, crust, ordinary chondrite