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Angrite meteorites and the earliest magma ocean

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Angrites are magmatic meteorites from an early planetesimal that is different from more typical "basaltic eucrites" because of silica undersaturation (absence of orthopyroxene), a relatively high redox state, and with high Ca/Al compared to most basalts. We have recently present results of 'reversal' crystallization experiments for the parental angrite composition represented by the large D'Orbigny angrite (McKibbin and O'Neill, Accepted Manuscript) to investigate the role of spinel as a sink for Al. The partitioning of Al is especially important for planetesimals formed during the first few million years of Solar System history because the radioactive isotope Al-26 was a major heat source for differentiation. Spinel has previously been produced with angritic melts during 'forward' melting of CV chondrite and may be abundant in the angrite source. At oxidizing conditions typical of angrites, spinel is a liquidus phase and angritic magmas probably form near the olivine-anorthite-spinel-liquid peritectic. A stability gap separates Al-rich liquidus spinels and lower temperature spinels with large ulvöspinel and magnetite components, similar to those found in basaltic eucrites. If a refractory CV-chondrite-like bulk planetesimal is responsible for angrites, then Al-rich spinel is likely more abundant in the source than other Fe-rich core-forming components such as metal or sulfide. The wide range of exposure ages for first gerenation angrites indicate that this type of magmatism was global on the angrite parent body. We can therefore outline a relatively deep global magma ocean with dense Al-spinel at the floor exerting strong influence on the thermal evolution of the angrite magma ocean. This evolution is different to that suggested for basaltic eucrites, ureilites and similar meteorites whereby radioactive Al-26 is extracted from the parent body via crust formation, acting to suppress magma ocean formation.

McKibbin, S. J. and O'Neill, H. St. C. (2018). Petrogenesis of D'Orbigny-like angrite meteorites and the role of spinel in the angrite source. Meteoritics and Planetary Science (In press).