ASTEROIDS ENRICHED IN REFRACTORY INCLUSIONS: EVIDENCE OF ACCRETION PRIOR TO THE INJECTION OF RADIOGENIC ALUMINUM INTO THE SOLAR SYSTEM.

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Introduction: Calcium-rich, aluminum-rich inclusions (CAIs) found within all chondritic meteorites are arguably the oldest rocks in our collections. CAI's contain refractory minerals that are the first phases predicted to condense from a gas of solar, or enhanced solar, composition. The highest abundance of CAIs are found in CO chondrites (<13 vol.%), but CV3 chondrites contain the most diverse range of CAI types with abundances of up to 10 vol.% (1). Burbine *et al*. (2) identified CAIs on two dynamically related asteroids, 387 Aquitania and 980 Anacostia, which they argued contain CAI abundances of 5-10%, similar to that observed in CV3 meteorites. Since the early solar nebula evolved quickly and was spatially heterogeneous, it is reasonable to assume that asteroids with higher concentrations of CAIs should exist.

Spectral Analyses: Using the SpeX instrument at the IRTF, we verified the identifications of Burbine *et al.* (2) and located additional asteroids with strong 2 µm absorptions; see **Fig. 1**. Among the minerals in CAIs only spinel ($MgAl_2O_4$) has significant absorptions features in near-infrared spectra. If even minor amounts of FeO are present, spinel has a strong 2 µm absorption. To support our analysis of asteroid spectra, we also collected spectra from CAIs within the Allende CV3 meteorite, including samples of CAI-free matrix. Using these components and estimating absolute albedo from IRAS, we then modeled the asteroids using Hapke theory (4) and determined that they contain 30±10% CAIs; see **Fig. 2**.

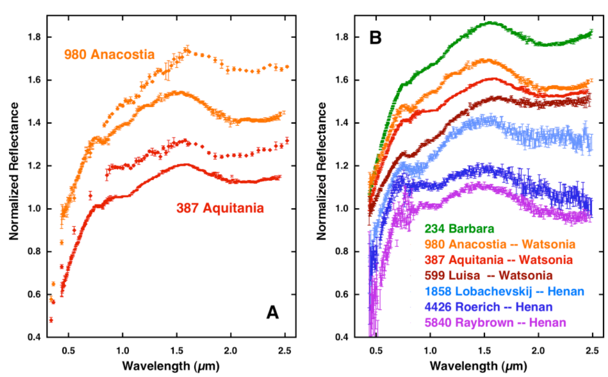

Fig. 1*: (A) Spectra of asteroids 387 Aquitania (red) and 980 Anacostia (orange) from Burbine et al. (2) compared with the current higher spectral resolution SpeX data (3). (B) SpeX data for asteroid 234 Barbara (green) and representative asteroids from the Watsonia and Henan families. All spectra are dominated by strong 2 µm absorptions.*

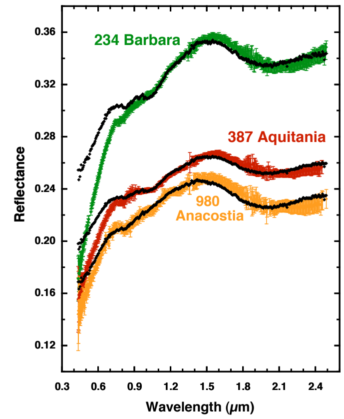

Fig. 2*: Models of CAI-rich asteroid spectra using spectral components from Allende. Although errors exist in the visible, models with 30±10% CAIs generally match all three asteroid spectra, particularly the near infrared absorptions.*

Timing of ^{26}Al Injection: The existence of these objects, some of which are 100 km in diameter, allows us to test hypotheses for the timing of events in the early Solar System. If these asteroids had accreted during the first few half-lives of ^{26}Al (~720,000 yr.) with ~30% CAI material that contained canonical $^{26}Al/^{27}Al$ ratios, they would have melted (5). While we cannot rule out that these asteroids accreted with additional materials that prevented melting, a plausible explanation for their survival is that they do not contain canonical ^{26}Al abundances. If these CAI-rich asteroids accreted from ^{26}Al-poor materials, they may record an early period of Solar System history when refractory materials were prevalent but before the injection of ^{26}Al into the Solar System. Thus, these asteroids have 2-3 times more CAI material and are more ancient than any known sample in our meteorite collection, making them prime candidates for sample return.

References: [1] MacPherson *et al.* (1988) *Meteor. Early Sol. Sys.*. [2] Burbine, T. H. (1992) *Meteor.* [3] Rayner (2004) *SPIE*. [4] B. Hapke (1993) *Theory of Reflectance and Emittance Spectroscopy*, pp. 455 [5] A. Das and G. Srinivasan (2007), *LPSC XXXVIII*, #2370.

Acknowledgements: This research is funded by NASA grants NNX06AH69G (JMS), NNG05GF39G (HCC), and NNG06GF56G (TLM) and NSF Grant AST-0307688 (SJB). We are indebted to T. Hiroi for carefully collecting our spectra at RELAB and K. Domanik for assistance with the electron microprobe at LPL.