WHERE DID ANOMALOUS BASALTIC METEORITES GET THEIR OXYGEN ANOMALY? THE CASE OF BUNBURRA ROCKHOLE.

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Introduction: A number of eucrite-like basaltic meteorites have been identified that have oxygen compositions, which plot away from the HED mass fractionation line ($\Delta^{17}O$ = -0.242 ± 0.016‰ [1,2]). The suggestion is that these rocks come from bodies other than 4 Vesta [2], an observation that has significance for the diversity of differentiated objects in the early solar system. But an alternate explanation is that some are impact breccias, which contain a non-HED contaminant [3]. JaH 556 is a howardite impact melt breccia that contains an estimated 20% H chondrite material [4]. Bunburra Rockhole (BR) was the first Desert Fireball Network recovery: a basaltic achondrite breccia with anomalous oxygen ($\Delta^{17}O$ = -0.112±0.042‰ [5]). In other respects it is similar to 'normal' eucrites. BR provides an excellent opportunity to understand the origin of anomalous basaltic meteorites where clear evidence of impactor material is lacking.

Results & Discussion: We have analyzed additional aliquots of BR to assess whether a mixing line can be identified in the O-isotope data. The range of $\Delta^{17}O$ values is limited (<0.1‰) with little variation in $\delta^{18}O$, therefore the presence of a mixing line is difficult to establish. If one was present, the data is consistent with normal eucrites as one end member. Given their O-isotope composition, ordinary chondrites (OCs) would be a possible other end member, as in the case of JaH 556 [4]. However, an OC contaminant cannot be responsible for the variation in BR. A significant fraction (>10%) of impactor material would be required. Micro-CT of 150g and 174g BR masses does not reveal any contaminant with a density contrast at scales >30µm, and no evidence of contaminants is found in BSE maps of two large (~3cm^2) polished sections (at scales >10µm). BR contains lithologies with varying grain size but that are texturally similar to non-cumulate eucrites – indicating it is not an impact melt breccia. And the trace element composition of BR pyroxene and plagioclase, and its bulk trace element composition [6], are indistinguishable from common non-cumulate eucrites.

Our existing data place interesting constraints on the origin of BR. If BR is from Vesta, it would require that an impactor contaminant was itself an anomalous achondrite, or that Vesta has greater isotopic heterogeneity than has so far been considered [1,2]. If BR is from a distinct body, then it is chemically indistinguishable from eucrites (at the level of REE partitioning).

Future Work: To address these questions we are performing coordinated O-isotope, trace element, and petrographic studies on multiple samples from different lithologies. Our goal is to elucidate the genesis of this unusual meteorite.

References: [1] Greenwood R.C. et al. 2005. *Nature* 435:916-918. [2] Scott E.R.D. et al. 2009. *GCA* 73:5835-5853. [3] Greenwood R.C. et al. 2012. Abstract #2711. 43rd Lunar & Planetary Science Conference. [4] Janots E. et al. 2012. *MAPS* 47:1558-1574. [5] Bland P.A. et al. 2009. *Science* 325:1525-1527. [6] Spivak-Birndorf L.J. et al. 2013. *MAPS* (in review).