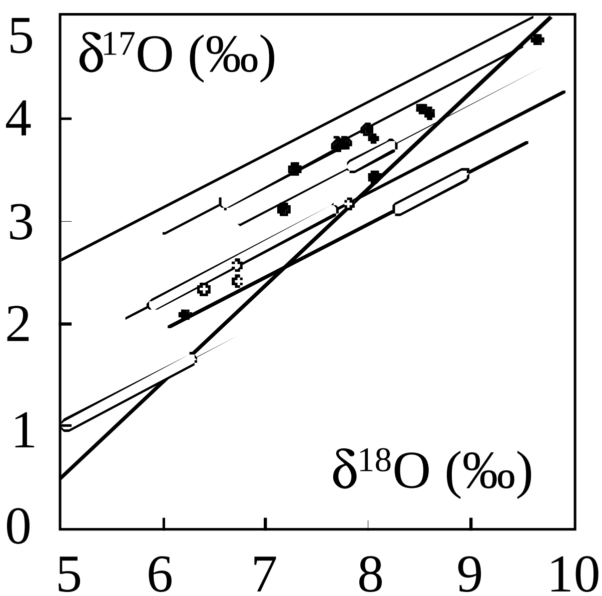
OXYGEN ISOTOPES, UREILITE GENESIS, AND THE GEOLOGY OF ASTEROIDS. R. D. Ash[1, 3], G. J. MacPherson[2], and D. Rumble III[3], [1]Department of Earth Sciences, University of Oxford, Parks Road, OX1 3PR, UK (richarda@earth.ox.ac.uk), [2]Department of Mineral Sciences, National Museum of Natural History, Smithsonian Institution, MRC NHB-119, Washington DC 20560, USA, [3]Geophysical Laboratory, Carnegie Institution, 5251 Broad Branch Road NW, Washington DC 20015-1305, USA.

Introduction: The ureilites are the most abundant of the primitive achondrites. They exhibit a combination of chemical and textural characteristics of igneous rocks [1] coupled with other chemical and oxygen isotopic signatures which appear to have been inherited from the nebula [2]. We have used high precision oxygen isotope analysis to investigate the relationship between the individuals of this group, in an attempt to deconvolve their nebula from parent body histories.

Methods, Samples and Results: High precision UV laser fluorination [3] analysis of monomict and unbrecciated ureilites shows that each of the meteorites defines a mass fractionation line, entirely consistent with their formation by normal igneous processes. However they cannot have been produced from a single homogeneous reservoir as most define separate and distinct fractionation lines.



In order to determine whether these represent separate parent bodies or a single, undifferentiated body we have analysed clasts in the polymict ureilites, a subset of brecciated ureilites which are made up of mineralogically and petrographically distinct ureilitic clasts. The results for these analyses are shown in the figure. (Crosses are analyses for individual clasts, fractionation lines and ellipses are the fields of data for monomict ureilites [4).

Discussion: The polymict ureilites, Nilpena and Dingo Pup Donga are composed of clasts derived from igneous rocks isotopically indistinguishable from the monomict ureilites. The former consists largely of Goalpara-like clasts, the of latter of Novo Urei and Kenna. The lack of alien material in these breccias suggests that they were derived entirely from local materials and not from a widespread mix of meteorite types.

From these observations we infer that the parent asteroid of the ureilites was large enough to have retained sufficient heat for partial melting and the migration of low degrees of basaltic melt. However the degree of melting was insufficient for magma ocean development thereby avoiding global isotopic homogenisation. The limited extent of the melting resulted in chemically and isotopically distinct magma chambers reflecting the signatures inherited from the local, heterogeneous carbonaceous chondrite-like precursor materials - the latter sampled in the dark clasts found in polymict ureilites. Impacts led to mixing of materials from several regions producing the polymict ureilites.

That ureilites formed from heterogeneous parent material suggests that there would be no simple igneous fractionation trends between them, although samples with the same $\Delta^{17}O$ values may be derived by fractionation from the same reservoir.

Implications for primitive achondrites: The ureilites, and possibly other primitive achondrites represent bodies of an intermediate size between small, chondritic bodies, which retain primitive nebular derived assemblages, and large bodies which underwent global melting, differentiation and core formation and are characterised by chemical and isotopic signatures indicative of fractionation of an homogenised reservoir.

References: [1] Goodrich C. A. (1992) *Meteoritics, 20,* 327–352. [2] Clayton R. N. and Mayeda T. K. (1988) *GCA, 52,* 1313–1318. [3] Rumble D. III et al. (1997) *GCA, 61,* 4229–4234. [4] MacPherson G. J. et *al.* (1998) *MAPS, 34,* A96–A97.