A NEW BRACHINITE AND PETROGENESIS OF THE GROUP.

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Summary. A new meteorite, tentatively called Australia 1, was found to be a brachinite, the sixth member of this group. Brachinites (BRA) can now be divided into two subgroups, three of which are near-chondritic or Undepleted (UBRA) and three that are subchondritic or Depleted in basaltic component (DBRA). AUS 1 is a DBRA. Brachinites are primitive achondrites whose petrogenesis began with oxidized chondritic material of CI-like composition that accreted to a parent body which was internally heated, equilibrating the metal into the silicates (mainly olivine) as oxide and converting most of the opx into more olivine. Partial melting occurred in local areas and the basaltic component is either unsampled or explosively removed from the planet. This was followed by thermal metamorphism of the UBRA and DBRA components, resulting in their highly equilibrated textures and mineral compositions, within a limited range. This scenario is analogous to that of the acapulcoite/lodranite primitive achondrite group, which also has undepleted (ACA) and depleted (LOD) members, but with a less oxidized composition.

New Brachinite. This meteorite is a primitive achondrite, the sixth brachinite, weighs 360g and is from Australia. Unofficially we call it Australia I (it is not yet named) and it comes from the Reid area of the Nullarbor plain. However, it differs from Reid 013 (=Nova 003; formerly Window Butte) and differs modally texturally and mineralogically from the four other brachinites. **Modal Data.** AUS 1 contains (vol.%) 92.7 ol, 1.6 opx, 3.6 cpx, <0.1 plag, 0.8 chromite, 0.1 phosphate (merrillite and chlorapatite), <0.1 FeNi metal and 1.2 troilite. The mineral assemblage is subchondritic, having depletions in opx, metal and plag, and perhaps cpx. It is one of the most ol-rich brachinites, which have from 74-97% olivine. Depletions in opx are typical of all brachinites, but some are also depleted in plag, and to some extent cpx. Thus, brachinites can be divided into two groups: (1) the Undepleted Brachinites (UBRA), including Brachina, Reid 013 and LEW88763, and (2) the Depleted Brachinites (DBRA), including ALH84025, Eagles Nest and AUS I. The UBRA are near-chondritic and the DBRA are subchondritic, being depleted in basaltic component as a result of a low degree of partial melting. They are analogous to the acapulcoite/lodranite (ACA/LOD)group, which consists of near-chondritic ACA and subchondritic LOD. However, the opx depletions in the brachinites are not due to partial melting, and is discussed below. **Texture.** AUS 1 is equigranular in texture, as are the other brachinites, with a grain size of 650 μm. Brachinites have a grain size which ranges from 100-750 μm, and AUS 1 is one of the coarser-grained members of the group. **Mineralogy.** The mineral assemblage is equilibrated and Fe-rich, with ol at Fo_{65}, opx at Wo_3En_{69} and cpx at $Wo_{47}En_{43}$. The plag is An_{32} and the chromite has an Fe/Fe+Mg ratio of 0.805 and a Cr/Cr+Al ratio of 0.727. FeNi metal is variable in composition, with 1-32% Ni. **Thermometry.** Coexisting opx and cpx give a closure temperature of 825°C, with the range for brachinites being from 825°-1070°C for this thermometer. Ca in coexisting ol and cpx gives a temperature of 1246°C, with the range for brachinites being from 965°-1246°C for this thermometer. The K_D of coexisting ol and chromite gives a temperature of 1000°C, with the range for brachinites being from 800°-1080°C for this thermometer. All of these thermometers have some experimental error associated with them. **Bulk Composition.** The composition of AUS 1 is being determined by INAA, and results are not yet available. The major element composition has been calculated from the modal and mineralogical data, and it is similar to that of the two other DBRA. It is dominated by the composition of olivine and therefore has low SiO_2 and high FeO and

MgO, similar to that of CI chondrites. **Oxygen Isotopes.** The oxygen isotopic composition of AUS 1 is $\delta^{18}O = 3.20$ and $\delta^{17}O = 1.48$. This composition is similar to that of the other brachinites, except for LEW88763, which differs from the others (as shown in Fig. 1). There is no isotopic distinction between the UBRA and the DBRA.

Petrogenesis. Brachinites are primitive achondrites because their compositions are near-chondritic and their textures are not. Texturally they are all equigranular, with compositionally homogenous Fe-rich mineral compositions dominated by olivine. These characteristics indicate that they are comparable to the ACA/LOD and silicate-inlcusions-in IAB and IIICD irons and winonaite (IAB-WIN) primitive achondrite groups, except that they are oxidized. The silicate-inclusions-in-IIE irons and IVA irons primitive achondrite groups formed in more evolved parent bodies, which developed complex fractionated assemblages. The petrogenesis of the brachinites involved a number of stages, as follows: (1) The starting materials were CI-like in major element composition, except for water, and thus resembles that of oxidized matrix. Brachinites are closer to CI in copmposition than any other primitive achondrite group. There was probably relatively little or no loss of metal from the original composition as the result of fractionation. Fe° was oxidized and incorporated into the silicates and the remaining metal and sulfide are Ni-rich. (2) After accretion the parent body was heated, with some regions experiencing partial melting while others did not. It was at this time that the Fe° was oxidized and opx reacted with the metal to produce more olivine, making the assemblage FeO- and olivine-rich. The reaction was: $MgSiO_3 + Fe^\circ + 0.5O_2 = (Mg,Fe)_2SiO_4$. Cpx was relatively unaffected by the oxidation process, but some was partially melted and fractionated, along with plag, to produce a basaltic component. (3) The extent of melting was limited, but heating or thermal metamorphism continued for a long period of time, resulting in equilibrated assemblages with a limited range of compositions. Thus, some brachinites are relatively undepleted (UBRA) and others lost a basalt-like component (DBRA). This component has either not been sampled or it may have been lost to the parent body by explosive volcanism. No reglothic breccias of brachinites have been found.

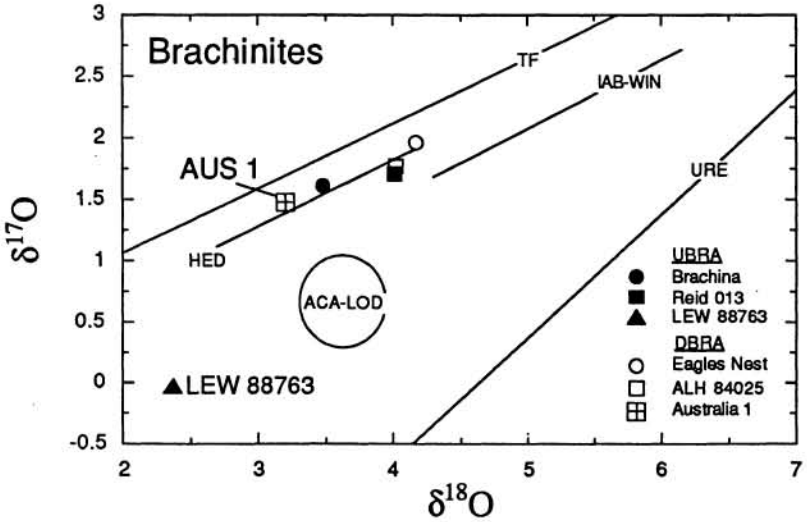

Fig. 1 Oxygen isotopic composition of AUS 1 compared with the other brachinites. There is no distinction between the UBRA and the DBRA isotopically. LEW 88763 is isotopically anomalous. HED overlaps BRA but are not related.