SAHARA 99555 AND D'ORBIGNY: POSSIBLE PRISTINE PARENT MAGMA OF QUENCHED ANGRITES. T. Mikouchi[1], G. A. McKay[2], J. H. Jones[2], [1]Dept. of Earth and Planet. Science, University of Tokyo, Hongo, Tokyo 113-0033, Japan (mikouchi@eps.s.u-tokyo.ac.jp), [2]SR, NASA-JSC, Houston, TX 77058, USA.

Introduction: Angrites constitute a small, but important group of basaltic achondrites showing unusual mineralogies and old crystallization ages [e.g., 1]. The currently known angrites are divided into two subgroups. Angra dos Reis (ADOR) and LEW86010 show slow cooling histories ("slowly-cooled" angrites) and differ from the later found angrites (LEW87051, Asuka 881371, Sahara 99555, D'Orbigny, NWA1670, NWA1298). This second group has textures that suggest rapid cooling histories ("quenched" angrites) [e.g., 2-3]. The petrogenesis of angrites has been controversial, partly due to the small number of available samples. In this abstract, we suggest a possible parent melt composition for the quenched angrites and its relationship to the partial melts of carbonaceous chondrites.

Olivine xenocrysts: One common characteristic of quenched angrites is the presence of exotic forsteritic olivine grains. These olivines are usually millimeter-sized megacrysts and more magnesian, Cr-rich and Ca-poor than the groundmass or phenocryst olivines (up to Fo_{96} vs. $Fo_{<85}$; 0.5 vs <0.1 wt% Cr_2O_3; and 0.4 vs. >0.7 wt% CaO) (Table 1). Because of their texture and because they are out of equilibrium with the groundmass, we concluded that they are xenocrysts [2]. The similar mineralogy of the groundmass minerals, as well as the presence of olivine xenocrysts, indicates that quenched angrites are petrogenetically related.

Bulk compositions of quenched angrites: We previously found strong correlations between some major element compositions and the abundance of olivine xenocrysts in these quenched angrites and pointed out that these compositional variations were best explained by olivine control [4]. The range of bulk compositions is 9.2-12.5 wt% Al_2O_3, 10.8-15.1 wt% CaO, 0.04-0.16 wt% Cr_2O_3, 6.5-19.4 wt% MgO, and 19-24.7 wt% FeO [e.g., 5]. No bulk composition has been reported yet for either NWA1670 or NWA1298. Because olivine xenocrysts are nearly absent in Sahara 99555 and D'Orbigny, we suggested that bulk compositions of these samples represent a pristine angrite magma composition that is not contaminated by the xenocryst component. In fact, these two angrites have nearly identical bulk compositions as pointed out by [5]. In contrast, LEW87051 and Asuka 881371 contain ~10% olivine xenocrysts. Moreover, these samples appear to contain large amounts of dissolved olivine xenocryst component. Addition of xenocrysts olivine (Fo_{90}, CaO: 0.4 wt% and Cr_2O_3: 0.45 wt%) to the bulk compositions of Sahara 99555 and D'Orbigny produces compositions that closely match the Al, Ca, Mg, and Cr abundances of LEW87051 and Asuka 881371 (Fig. 1). According to these results, LEW87051 and Asuka 881371 are estimated to contain ~40% and ~25% addition of olivine xenocryst component, respectively. Because these angrites contain only ~10% olivine xenocrysts observed, most of the olivine xenocryst component was dissolved in the groundmass melt. The degree of dissolution was more significant in LEW87051 than Asuka 881371. As a result, the groundmass minerals in LEW87051 are more magnesian than Asuka 881371 (Table 1). Probably, the smaller size of olivine xenocrysts in LEW87051 (as compared to Asuka 881371) indicates a larger degree of xenocryst dissolution for LEW87051. The bulk REE abundances of quenched angrites are also consistent with the major element variation explained above. LEW87051 and Asuka 881371 have lower REE abundance than Sahara 99555 and D'Orbigny [5], probably because olivine addition lowered the abundance of REEs in LEW87051 and Asuka 881371. Note that contrary to our usual petrologic experience, those angrites that are most magnesian are not the most primitive.

Relationship to partial melts of carbonaceous chondrites: The parent melts of quenched angrites are similar to experimental partial melts of carbonaceous chondrites (CV, CM) at 1200°C and logfO_2=IW+1~2 in terms of major elements [6]. Allende partial melts, especially, give the best fit. Since more detailed discussion is in [7], here we pay attention to the Ca and REE abundances of these melts. At 1200°C and IW+1~2, the degree of partial melting is ~15% and the solid residua are dominated by olivine [6]. Further, the olivines coexisting with the experimental melts have compositions ($Fo_{62\text{-}65}$) similar to the cores of groundmass olivines in the quenched angrites (Table 1). We calculated the abundances of Ca, Sm, Gd, and Yb in partial melts by assuming that only olivine and melt are present. Calcium and REE abundances of 15~20% partial melting of Allende match with those of Sahara 99555 and D'Orbigny (Table 2 and Fig. 2). Higher degrees of partial melting give more depleted abundances, which are clearly lower than those in Sahara 99555 and D'Orbigny. The same type of calculation for Murchison yields 10~15% partial melting for the REEs, but 5~10% partial melting best fits the Ca abundance. Thus, small degrees of partial melting (~15%) of CV or CM produce pristine angritic magma compositions, although the Allende melts are more similar to natural angrites than Murchison [7].

References: [1] Mittlefehldt D. W. et al. (1998) *Reviews in Mineralogy*, *36*, 4-131. [2] Mikouchi T. et al. (1996) *Proc. NIPR Symp. Antarct. Meteorites*, *9*, 174-188. [3] McKay G. et al. (1998) *Meteoritics & Planet. Sci.*, *33*, 977-983. [4] Mikouchi T. and McKay G. (2003) *Meteoritics & Planet. Sci.*, *38*, Supple. A116. [5] Mittlefehldt D. W. et al. (2002) *Meteoritics & Planet. Sci.*, *37*, 345-369. [6] Jurewicz A. J. G. et al. (1993) *GCA, 57*, 2123-2139. [7] Jurewicz A. J. G. et al. (2004) *LPS XXXV* (this volume). [8] Yanai K. et al. (1995) *Catalog of the Antarct. Meteorites*, 212. [9] Jarosewich E. (1971) *Meteoritics, 6*, 49-52. [10] Mikouchi T. et al. (1994) *LPS XXIV*, 907-908. [11] Nakamura N. and Masuda A. (1987) *Smithsonian Contrib. Earth Sci., 27*, 38. [12] McKay G. (1986) *GCA, 50*, 69-79.

Table 1. Characteristics of xenocryst and groundmass olivine in quenched angrites.

	Xenocryst size	Core of xenocryst olivine	Core of groundmass olivine	Observed xenocryst abundance	Calculated xenocryst abundance
LEW87051	~0.5 mm	Fo_{90-80}	Fo_{82}	~10 %	~40%
Asuka 881371	~2 mm	Fo_{90-70}	Fo_{70}	~10 %	~25%
Sahara 99555	-	-	Fo_{65}	-	-
D'Orbigny	~5 mm	Fo_{89}	Fo_{65}	~1 %	-
NWA1670	~3 mm	Fo_{96-85}	Fo_{85}	~20 %	-

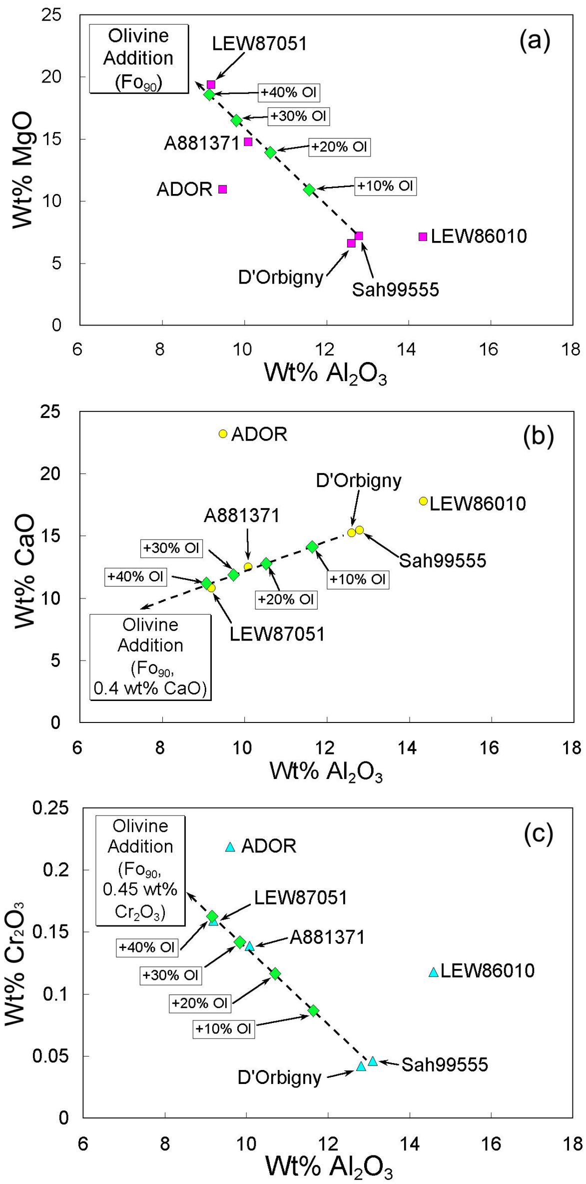

Fig. 1 (left). Calculated abundances of (a) Ca, (b) Mg, and (c) Cr versus Al by adding xenocrystic olivine (Fo_{90}, CaO: 0.4 wt%, Cr_2O_3: 0.45 wt%) to the bulk compositions of Sahara 99555 and D'Orbigny.

Table 2. Calculated CaO abundance (wt%) in partial melts of Allende and Murchison with variable melting degree.

	Wt% CaO	Partial melt abundance					
		5%	10%	15%	20%	25%	30%
Allende	2.49	28.3	18.3	13.5	10.7	8.9	7.6
Murchison	1.89	21.5	13.9	10.3	8.1	6.8	5.8
Sahara 99555	15.1						
D'Orbigny	15						

*Bulk chemical data of Allende and Murchison are from [8] and [9], respectively. The employed olivine/melt partition coefficient for Ca was 0.04 [10].

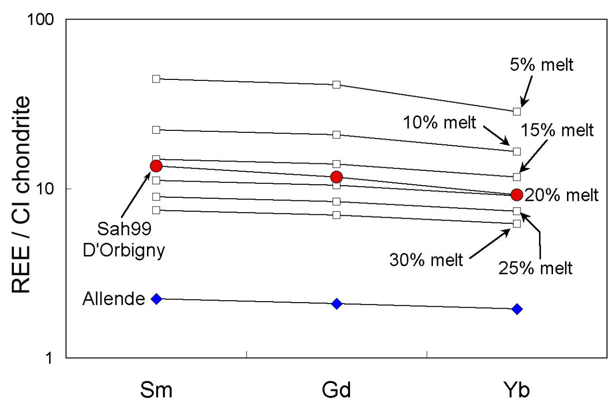

Fig. 2 (above). Calculated REE abundances in partial melts of Allende. Bulk chemical data of Allende is from [11]. The employed olivine/melt partition coefficients for Sm, Gd and Yb were 0.00058, 0.00102 and 0.0194, respectively [12].