POMOZDINO: AN ANOMALOUS, MAGNESIAN YET REE-RICH, EUCRITE

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The Pomozdino meteorite is an essentially unweathered find, originally 327 g. Previous studies have included a wet-chemical analysis and basic petrography [1] and an INAA study that determined REE, Sc, Cr, Co, and Ta [2]. Results indicated that Pomozdino is a brecciated but monomict eucrite with an extraordinary bulk composition. Mason et al. [3] also examined a thin section, which they briefly described as a "monomict breccia, the breccia fragments consisting of a subophitic intergrowth of plagioclase and pigeonite." In an effort to clarify the nature and origin of this unique eucrite, we have undertaken to study its geochemistry as part of a consortium that includes M. I. Petaev et al. (oxygen isotopes) and L. F. Migdisova et al. (detailed petrography and mineral chemistry).

Pomozdino consists of roughly 50-55 vol% large (up to 1 cm), little-brecciated clasts, amidst 45-50 vol% of a much finer-grained, cataclastic matrix [1,4]. The clast or "primary eucrite" [1] portions represent an uncommonly coarse-grained eucrite, with pyroxenes typically 2-3 mm across. Disparities among the analyses (including between our own two analyses) indicate that the meteorite is uncommonly heterogeneous, at least on the scale (223-238 mg) of the chips we analyzed. Kvasha and Dyakonova [1] analyzed a much larger chip, 5.3 g. This chemical heterogeneity is presumably related to the coarse granularity and the heterogeneous clast-matrix structure. Nevertheless, our results (most of which are shown in the Table) confirm that Pomozdino is a eucrite, and that its composition is extraordinary. The Ga/Al ratio (Figure 1) clearly distinguishes Pomozdino from SNC meteorites and brachinites, while its Fe/Mn (36) clearly distinguishes it from lunar samples (Fe/Mn virtually always between 60 and 100). Even more definitive (except vs. brachinites) are the results from Petaev et al. [5] for oxygen isotopes.

Kvasha and Dyakonova [1] found the bulk-rock 100Mg/(Mg+Fe) ratio (hereafter abbreviated as *mg*) to be 49.6. The average *mg* of our two analyses is lower, 44.9, but still clearly distinct from the highest *mg* of any noncumulate monomict eucrite, 41.5 (assuming that ALHA81001 [6] is not an impact melt). The 100MgO/(MgO+FeO) ratio reported by Kvasha and Dyakonova [1] is even more unusual, 55.9, for they found an extraordinarily high content of reduced Fe (0.91 wt% as metallic FeNi and 1.77 wt% as part of 2.79 wt% FeS). Most eucrites contain $<<1$ wt% of metallic FeNi and FeS combined [7]. Unfortunately, our techniques do not determine S, and they determine Fe only as total Fe. However, the concentration of the chalcophile Zn (especially in our "B" analysis, which also has higher Fe than "A") is far higher than the previous maximum (credible) Zn for eucrites, 9 μg/g [8]. Unusually high contents of metal and FeS are also observed petrographically [1,4]. One section for which Kvasha and Dyakoniva [1972] obtained a mode has (in vol%): 63.5% pyroxene, 31.5% plagioclase plus tridymite (tridymite, roughly estimated, $\sim$3%), and a total opaques content of 5%. However, these authors note that their own chemical analysis indicates a less extreme opaques content, more like that of a different section's mode: 2 vol% opaques of which FeS $\sim$0.8%, oxides $\sim$0.8%, and FeNi $\sim$0.4%.

Despite its high *mg*, Pomozdino is uncommonly rich in REE. Our REE results are considerably higher than those of Kolesov [2]. Kolesov's [2] data show an unusual depletion of La relative to other light REE, but this feature is not evident in our two analyses. In any event, the Ce/Lu ratio is clearly high ($1.6 \pm 0.2 \times$ CI) by eucrite standards, slightly higher than even those of Stannern and Bouvante [9].

On a plot of *mg* vs. an incompatible element such as Sm (Figure 2), varying degrees of fractional crystallization of a given original melt should engender a near-horizontal trend of samples; varying degrees of equilibrium partial melting of a single source composition should engender a near-vertical trend [6]. Plots of this type have been used to classify the noncumulate eucrites into (a) a "Main Group," (b) a putative fractional crystallization sequence, the "Nuevo Laredo Trend," and (c) a putative partial melting sequence, the "Stannern Trend" [10]. However, the division between the Main Group and the Nuevo Laredo Trend is hardly evident after compilation and averaging of all literature data for monomict eucrites (Figure 2). Also unclear from these data are the scope and significance of the Stannern Trend. Except for Bouvante, no other monomict eucrite has the combination of high Sm with moderate, Stannern-like *mg* that should characterize a partial melting trend (dashed line in Figure 2). Even Bouvante contains an enclave [9] with the same *mg* as our Pomozdino "B" analysis. Pomozdino is too magnesian and Sm-rich to fit into any of the three BVSP [10] classes of noncumulate eucrites.

Unusually Sm-rich clasts "BF7" and "CF4" from the Kapoeta howardite [11] are arguably along an extension of the Stannern Trend, and like Pomozdino, the CF4 clast is unusually FeS-rich [12]. The

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texture of Pomozdino may be too brecciated to reveal any obvious constraint on its ultimate origin. However, its coarse granularity, its high pyroxene/plagioclase ratio, and the Mg-rich compositions of its minerals, all suggest that Pomozdino formed at least partially as a cumulate [4]. The high contents of Sm and other incompatible elements imply (assuming a reasonably eucrite-like Sm content for the parent melt) that the ratio of cumulus matter to "trapped" melt must be modest, however. If the bulk-rock *mg* ratio is modeled as a melt with Stannern-like *mg* diluted solely by cumulus crystals or phenocrysts of pyroxene (assuming equilibrium with the Stannern-like melt governed by $K_D = 0.3$, the cumulus pyroxene would be *mg*-67), then only 15-26 wt% of cumulus or phenocryst pyroxene is implied (depending upon which bulk-rock analysis is used). However, allowing for the unusually high reduced-Fe content of Pomozdino, the implied content of cumulus or phenocryst pyroxene is roughly 40%. If the parent melt's *mg* was more like that of BF7, the implied content of cumulus pyroxene would be higher still (~60 wt%). The parent melt Sm contents implied by these models are at least 1.3 × the actual Stannern and BF7 compositions (cumulus phases other than pyroxene might have further diluted the "trapped" melt). Thus, its anomalous bulk composition notwithstanding, Pomozdino may have formed from a melt in the general vicinity of the putative Stannern Trend. By the same token, however, most of the traditional cumulate eucrites probably formed from melts along a low-*mg*, moderate-Sm extension of the Nuevo Laredo Trend. It may be significant that Bouvante, the eucrite that most resembles Pomozdino from a compositional standpoint, also resembles Pomozdino texturally [1,4,9,13].

References: [1] Kvasha L. G. and Dyakonova M. I. (1972) *Meteoritika* **31**, 109-115. [2] Kolesov G. M. (1976) *Meteoritika* **35**, 59-66. [3] Mason B. et al. (1979) *Smiths. Contrib. Earth Sci.* **22**, 27-45. [4] Migdisova L. F. et al. (1988) *LPS XIX*, this volume. [5] Petaev M. I. et al. (1988) *LPS XIX*, this volume. [6] Warren P. H. and Jerde E. A. (1987) *Geoch. Cosmoch. Acta* **51**, 713-725. [7] Duke M. B. and Silver L. T. (1967) *Geoch. Cosmoch. Acta* **31**, 1637-1665. [8] Chou C.-L. et al. (1976) *PLSC 7th*, 3501-3518. [9] Christophe Michel-Levy M. et al. (1987) *Bull. Minéral.* **110**, 449-458. [10] Basaltic Volcanism Study Project (1981) *Basaltic Volcanism on the Terrestrial Planets*, Pergamon. [11] Smith M. R. (1982) Ph.D. dissertation, Oregon St. U. [12] Warren P. H. et al. (1982) *Meteoritics* **17**, 293-294. [13] Delaney J. S. et al. (1984) *LPS XV*, 210-211.

TABLE. Concentrations of 26 elements in Pomozdino (trace elements in μg/g, except Ir, ng/g; others mg/g).

	Na	Mg	Al	Si	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co
Ref. [1]	3.04	60.1	59.9	224.2	0.2	76.9	-	4.38	-	0.7	4.1	140.3	10
Ref. [2]	-	-	-	-	-	-	23	-	-	3.9	-	-	9
This work A	3.67	52.6	60.7	232.9	0.40	69.6	28.8	6.5	73	2.96	3.66	139.4	5.0
This work B	3.23	53	55.6	234.6	0.33	66.2	30.0	5.5	72	3.66	4.27	154.3	13.6

	Ni	Zn	Ga	Sr	Ba	La	Ce	Sm	Eu	Lu	Ta	Ir	Th
Ref. [1]	-	-	-	-	-	-	-	-	-	-	-	-	-
Ref. [2]	-	-	-	-	-	2.6	9	2.3	0.66	0.20	0.20	-	-
This work A	<44	13	2.1	117	57	6.0	15.2	3.3	0.91	0.42	0.30	<3	0.71
This work B	<79	28	1.13	108	62	5.2	13.2	2.8	0.78	0.39	0.27	<6	0.68

FIGURE 1

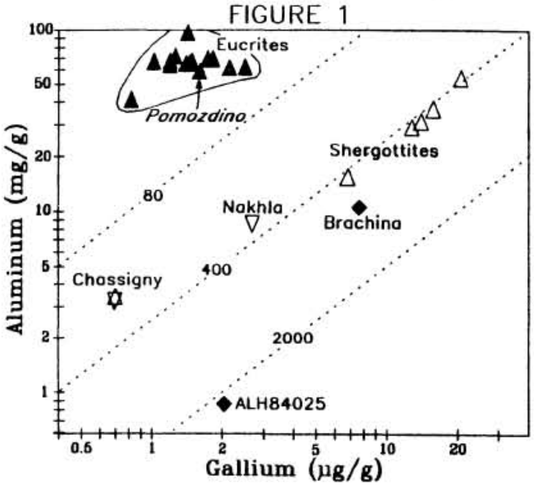
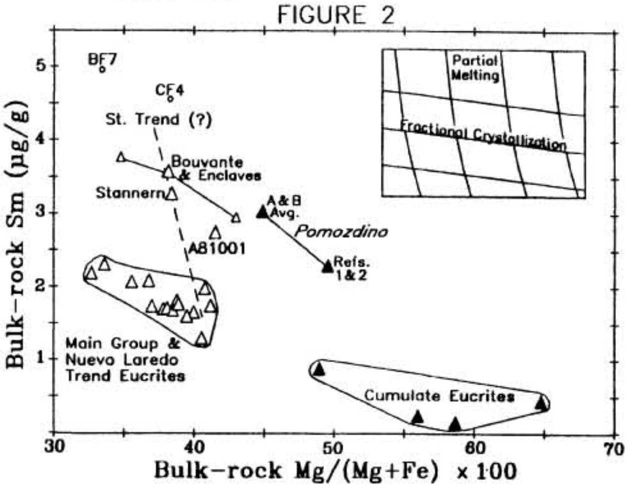


FIGURE 2



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