TRACE ELEMENT DATA ON ENSTATITE CHONDRITE COMPONENTS AND THE QINGZHEN ENSTATITE CHONDRITE. Sheng, Z., W. Sallee and D.W.G. Sears, Department of Chemistry, University of Arkansas, Fayetteville, AR 72701.

The enstatite chondrites are two, small (23 members) but particularly important groups of meteorites (1). Their importance lies in their high state of reduction which seems to imply an origin much closer to the sun than the other chondritic meteorites (2-5). They also seem to require either a complex condensation/accretion history (5) or that the nebula was of unusual composition in the region in which these classes formed (2,3). We are investigating the origin of these little-studied groups by detailed measurements of their compositions and by thermodynamic modeling. We report here the results of our preliminary work on the Qingzhen enstatite chondrite and on two kinds of material from the Abee enstatite chondrite, a dark inclusion and a sample of matrix.

Qingzhen has been described and analyzed, by wet chemical means, by Wang and Xie (6) who classify it as an EH4 chondrite. Our data are in good agreement with theirs and we concur with their classification (Table 1). The refractory lithophile element abundances, normalized to Cr (an element with a similar nebula volatility to Si) are appreciably lower in Qingzhen (Sm/Cr=0.046) than in the carbonaceous and ordinary classes (Sm/Cr=0.06-0.08), and the siderophile and chalcophile elements indicate that Qingzhen is EH rather than EL, since these elements are a factor of ~1.5 higher in EH chondrites.

Table 1. Composition and Classification of Qingzhen (*mg/g others μg/g)

	Ir	Ni*	Co	Fe*	Au	Sc	La	Sm	Cr	Na*	Se	Zn
Present work	501	19.6	873	308	314	5.9	0.217	0.149	3266	6.8	19	180
Wang and Xie	-	18.1	930	316	-	-	-	-	1916	7.9	-	270
Mean EH (7)	565	19.0	900	310	360	6.2	0.246	0.150	3500	7.3	26	450

The sample of Abee matrix (UCSD 5,9,1) has essentially mean EH abundance of all elements except Sc (30% depleted) and Zn (50% depleted) (Fig. 1) and it resembles Abee clast UCSD 2,1 (7). Manganese, which is located in the niningerite, (Mg,Fe)S, displays good correlations with Sc, and the variability of these elements in Abee probably reflects variations in the amount of niningerite, which is particularly abundant in this meteorite (8). The data would therefore be consistent with the formation of Abee matrix by comminution of clasts resembling 2,1.

The most noteworthy feature of the Abee dark inclusions are enrichments of rare earth elements. For various reasons Sears et al. (7) surmised that REE were located in CaS and therefore the inclusions were rich in this mineral. However, petrologic observations on the two inclusions studied by Sears et al. failed to confirm this (9). On the other hand, a 2x1x>1.5 cm dark inclusion (5,1) subsequently sampled was found to be CaS enriched (5.9% vs. <1% in most EH chondrites (9)). Two samples of this inclusion were therefore analyzed by NAA and the results are presented in Figure 2. Their compositions are very much like the previous two inclusions studied. This confirms the conclusion that the REE are located in CaS; the absence of CaS in the two previous inclusions is probably due to water leaching of these two small surficial inclusions.

Since Abee is an impact breccia, a plausible theory for the origin of the dark inclusions is that they are the residual solids from an impactinduced partial melt. Problems with this explanation are (i) the abundance of low melting FeS in the dark inclusions, (ii) the ubiquity of these inclusions and the absence of melts showing intermediate degrees of partial melting, and (iii) the presence in the inclusions of unaltered chondrules. A high CaS content could result from a high temperature formation in the nebula (10,11), and would be consistent with the thermodynamic models which suggest that, in a reducing gas (C=2x cosmic), La and Eu condense as solid solutions in CaS (7). Our Eu calculations have not been published before. We find that Eu(g) condenses as EuS solid solution and that, as in a cosmic gas, Eu is relatively volatile (50% T (Cond) = 1220K, at 10^{-4} atm, vs. 1304 K for La). The negative Eu anomaly could therefore be explained by isolation of the inclusions after condensation of La and before complete condensation of Eu. However, thermodynamic calculations do not explain the Sc depletion since its 50% T (Cond) is ~50° higher than that of CaS (7) nor do they explain the abundance of FeS. Consequently we conclude that neither partial melting nor fractional condensation are capable of producing the dark inclusions in a simple one-step process and therefore the inclusions must have a fairly complex multistage history.

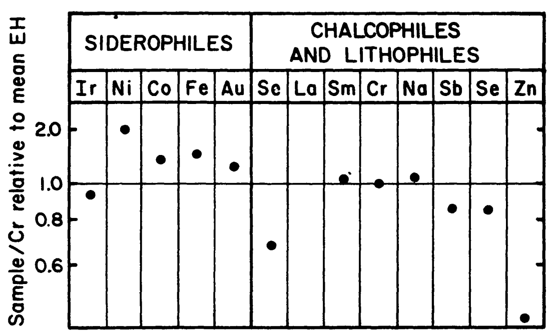

Fig. 1. Cr-normalized abundances in an Abee matrix sample.

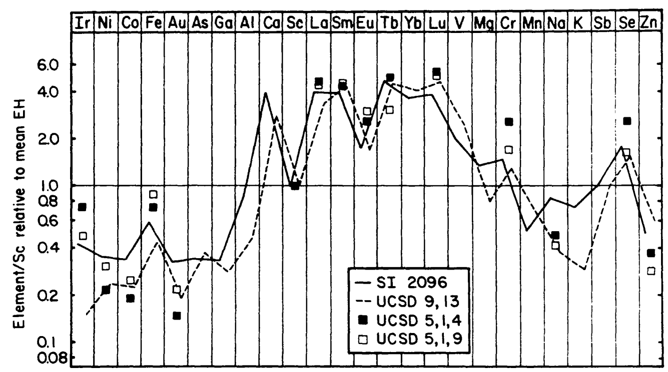

Fig. 2. Sc-normalized abundances (Cr too high for precise measurment) in Abee dark inclusions.

1. Sears D.W. et al. (1982) Geochim. Cosmochim. Acta (in press).
2. Larimer J.W. (1968) Geochim. Cosmochim. Acta 32, 965-982.
3. Baedecker P.A. and Wasson J.T. (1975) Geochim. Cosmochem. Acta 39, 735-765.
4. Wasson J.T. (1977) In Comets, Asteroids, Meteorites: Interrelations, Evolution and Origins (A.H. Delsemme, ed.) U. Toledo, 551-559.
5. Sears D.W. (1980) Icarus 43, 184-202.
6. Wang D. and Xie X. (1981) Geochimica 277-287.
7. Sears D.W. et al. (1982) Earth Planet. Sci. Lett. (submitted).
8. Keil K. (1968) J. Geophys. Res. 73, 6945-6976.
9. Rubin E.A. and Keil K. (1982) Earth Planet. Sci. Lett. (submitted).
10. Lattimer J.M. and Grossman L. (1978) Moon and Planets 19, 169-184.
11. Larimer J.W. and Bartholomay M. (1979) Geochim. Cosmochim. Acta 43,1455-66.