TRACE ELEMENTS IN MINERAL SEPARATES OF THE PEÑA BLANCA SPRINGS AUBRITE; K.Lodders and H.Palme, MPI f. Chemie, Saarstr.23, 6500 Mainz, Germany

Enstatite achondrites (aubrites) are highly reduced meteorites consisting mainly of Fe-free enstatite (>95%). Minor phases include plagioclase, Si-bearing metal, troilite and various other sulfides, such as oldhamite (CaS), ferroan alabandite (Fe(Mn)S), and daubreelite ($FeCr_2S_4$). Trace element abundances in aubrite minerals provide information on the origin of these unusual meteorites.

The Pena Blanca Springs (PBS) aubrite fell in 1946 and about 70 kg were recovered [1]. A piece of 5 x 1.5 x 1 cm from the Mainz collection was dry-cut. About 7.7 g were powdered in an agate mortar and an aliquot of 240 mg was used for bulk analysis. Another part (11.4 g) was gently crushed and troilite, oldhamite, and white and grey pyroxene fractions were separated by hand-picking under the binocular. All fractions were analysed by INAA. Results of analyses on bulk and mineral separates are given in Table 1.

Bulk analysis: Refractory elements are present at 50% of the CI-level (relative to Mg). The pattern is slightly fractionated with a small negative Eu-anomaly and the notable exception of V which is depleted by nearly a factor of 10. Metal/sulfide removal must have occurred at sufficiently reducing conditions to ensure removal of V with metal. Vanadium, therefore, provides a means to determine the oxygen fugacity during metal-silicate fractionation. The contents of all other, more siderophile elements are below detection limit.

Oldhamite: Two grains of 4.1 mg (> 80% CaS) and 0.097 mg (> 70% CaS) were separated. Both grains are highly enriched in REE, about 450x CI for the large and 150x CI for the smaller grain. The REE content in the large grain is higher than in most CaS grains analyzed in aubrites and E-Chondrites [2-6]. With a modal CaS content of 0.3 wt-% obtained by leaching (see below) the REE in the large CaS grain are higher than expected assuming that REE are quantitatively contained in CaS. Small CaS grains should therefore have lower REE to compensate the high contents in the large grains. Decreasing REE contents with decreasing grain size is expected since small grains more readily loose their initially high REE content by equilibration with pyroxene. We have previously shown that equilibrium partitioning produces CaS/px REE ratios of 80 to 10, compared to 500 to 200 found here. If large CaS grains are not in equilibrium with px, their high REE-level must have been established by condensation [4,7]. The negative Eu anomaly in CaS may reflect preferred redistribution of Eu between CaS and plagioclase.

Troilite: REE in troilite are not unexpected, considering earlier results from FeS/silicate partition experiments [8]. The CI normalized REE pattern is flat at about 0.8xCI with a negative Eu-anomaly. However, the negative Eu-anomaly may reflect the presence of plagioclase and some Eu redistribution.

Pyroxene: Two px separates were analysed. The major fraction of enstatite is designated as "grey" px fraction in Table 1. Rare "white" px is higher in Ca and Sc, the REE pattern shows a distinct negative Eu-anomaly.

Results of a **leaching experiment** with 200 mg of powdered sample are shown in Fig 1. All soluble Ca is dissolved during the first leaching step in H_2O, while most REE and Sc appear in the second leaching step in the NH_4Cl and HCl fractions, although REE and Sc are highly concentrated in CaS (see Table 1). Dissolution of REE and Sc appears to be pH dependent. The amount of 20 % soluble Ca corresponds to a modal CaS content of about 0.3 wt% for PBS. Plagioclase is not affected by leaching procedures, the small fraction of Na and K dissolved may indicate dissolution of Na, K bearing sulfides. Plagioclase, a major host phase for Eu, may also account for the smaller fraction of Eu dissolved compared to other REE. Further analyses on the separated mineral fraction are in progress.

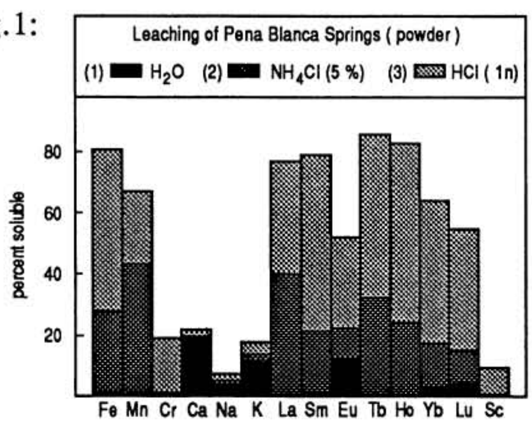
TRACE ELEMENTS IN MINERALS OF PBS: K.LODDERS AND H.PALME

Table 1: Elemental abundances in bulk and separated phases of Pena Blanca Springs

	bulk		Oldhamite		Oldhamite		Troilite		Pyroxene white		Pyroxene grey
weight (mg)	240		4.107		0.097		4.06		17.62		30.53 preliminary data
%											
Mg	21.07	(5)	<1.8		<1.9		0.30	(30)	21.08	(5)	*n.a*
Al	0.77	(5)	<0.1		0.5	(5)	0.014	(15)	0.31	(5)	*n.a*
Ca	0.68	(8)	45.34	(5)	39.74	(5)	0.089	(20)	4.09	(5)	*<0.4*
Ti	<0.03		<0.44		<0.3		1.20	(5)	0.052	(20)	*n.a*
Fe	0.53	(3)	1.60	(4)	1.72	(15)	55.64	(3)	0.023	(15)	*0.41*
ppm											
Na	4990	(3)	917	(3)	1180	(3)	69.0	(3)	1780	(3)	*1100*
K	245	(7)	<150		<190		390	(3)	82	(15)	*90*
Sc	6.04	(3)	28.5	(3)	84.5	(4)	0.35	(20)	18.9	(3)	*4.5*
V	6.6	(15)	<24		100	(20)	795	(3)	<1.4		*n.a.*
Cr	528	(3)	1640	(3)	1080	(7)	8330	(3)	31.7	(5)	*268*
Mn	1170	(3)	22780	(3)	16300	(3)	1205	(3)	134	(3)	*510*
Se	2.2	(7)	198	(4)	130	(15)	144	(5)	-		-
La	0.19	(7)	83.8	(4)	21.3	(7)	0.13	(20)	0.15	(30)	*0.37*
Ce	0.42	(20)	294	(6)	85	(20)	-		-		-
Nd	-		203	(5)	53	(30)	-		-		-
Sm	0.157	(3)	73.5	(3)	24.3	(3)	0.120	(5)	0.134	(3)	*0.110*
Eu	0.051	(15)	5.38	(3)	5.77	(5)	0.018	(10)	0.020	(30)	*0.037*
Tb	0.037	(15)	18.0	(7)	7.1	(20)	-		-		-
Dy	0.27	(15)	107.5	(7)	37.5	(7)	0.16	(20)	<0.07		-
Ho	0.051	(10)	21.9	(8)	8.0	(3)	0.03	(30)	0.05	(20)	*0.03*
Yb	0.17	(7)	61.7	(3)	21.6	(8)	0.14	(30)	0.20	(15)	*0.13*
Lu	0.027	(10)	9.13	(3)	3.1	(10)	0.04	(25)	0.040	(30)	*0.02*

(1σ standard derivation in percent, n.a. not analysed)

Fig.1:



Detection limit: Yb, Lu in H_2O; Ca in NH_4Cl

Lit.:

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