paleogeographic maps, where seashores for various geological epochs are usually limited by the margin contours of corresponding sedimentary successions preserved from erosion within the Khatungan Depression. The large Popigai Crater, ~35 Ma in age, with its well-preserved impact formation, may provide new insight into the open sheets of regional Phanerozoic history. The Popigai impact formation should contain a well-preserved collection of target sedimentary rocks in a large, ~100 km diameter, area of cratering. The explosion cloud deposits found within and the suevite megabreccias among them, should be the most interesting in this respect, especially if one takes into account a new model [1.2] of their transport during cratering (subvertical excavation for cape target formations). The data following are presented in order to support the thesis mentioned above.

The fragments of K1 rocks collected by one of us (S.V.) from the suevite megabreccia contain well-preserved "in situ Early Valanginian fauna of Bucha keyestings (Lahs) (layered leptite chert sandstone, northeast part of the entire structure)” as well as Early Valanginian fauna of Costaculus septentrionalis Belk., Belk., and Praecocissois cf. anaberesis Bodyl. and others (phosphate sandstone, north part of crater) specimen 2374/6. This fauna is evidence of open (100 km to seashore, at least) and shallow (20-40 m) sea. Other marine fauna of Valanginian age (bivalves and cephalopods) had been found in suevites of the crater by L.P. Smirnov (1957) and others, so there was an ocean regime in the Valanginian time on the northern part of the Anabar Shield.

M.T. Kirjashina and co-authors [3] that Late Jurassic-Bajocian fauna or Pseudomorpha (Eurhynchoda) (Arctoidea, in modern terminology) of Laehs, was collected in the central part of the crater (same carbonaceous concretion). Again, it is evidence of a shallow (<100 m) sea on the northern part of the shield.

A special quest for Paleogene rocks incorporated in Popigai impactites, was unsuccessful, but reworked Paleogene tree pollen (Tsuga, Abies), as well as marine Dinosauria were reported by A.O. Yefremov (1966) and others to be present in post-impact M2-M2' crater fill. Therefore, continental as well as marine regimes were also possible for the area in Paleogene time. The bulk composition of Popigai suevites enables us to estimate the approximate thickeness for Me+Peg cap of target. Subvertical excavation of crater during cratering should provide relatively uniform deposition of mobilized material. The top of the suevitic column (suevite sand, suevite megabreccia, and partly Me and Peg) is widespread in the crater and is prima- rily made up of Me + Peg (50%) material (up to 60% in some cases). This maximum thickness is up to 200 m (drilling data). So, the top should correspond to Me + Peg cap of target of up to 120-150 m in thickness, at least, and the northern part of the Anabar Shield was not a positive area only, but depositional (including marine regimes) basin also during the time considered. The references are described only the first steps in the use of such unique storage of regional paleogeochemistry as the Popigai Crater.


SAMARIUM-NEODYMIUM AND MANGANESE-CHROMIUM SYSTEMATICS IN THE EURITE CALDERA. M. Wachowa and G. W. Lugnagel, Scripps Institute of Oceanography, University of California, San Diego, La Jolla CA 92036-0212, USA.

Caldera, a final from Chile, is one of only two known uncorrelated non-erde deposit (the other being the Kuyecin). For this reason, it was deemed of great importance to perform on this craterite extensive radiometric and geologic studies in an attempt to better constrain the time of solidification of basaltic materials in the parent body (EPB) and thus the evolutive timescales of planetesimals. Compared to other uncorrelated erde deposits, Caldera has a very large gneiss size. Fortunately, there is extensive yellow-brown staining on almost all gneiss surfaces pervading the entire craterite. Because of the craterite’s very low terrestrial residence time, and the possible terrestrial origin of this staining, it is unlikely that its codeposition would be preserved. Moreover, examination of mineral sequestration can be achieved before the end of isotope measurements on mineral separates could be attempted. This proved to be extremely difficult, and up to 2 hr of etching in 18N HCl was required to achieve satisfactory results.

Phases consist of plagioclase + pyroxene, although partially etched but mostly clear of the surface coating, together with an affinity of an acid-decorated bulk sample and an unetched one, were dissolved and analyzed for Sm-Nd isotopic systems. There is a large spread in 147Sm/144Nd ratios between Forsterite and P (0.2056 and 0.2728, respectively). Excellent isotope ratios for both the Sm-Nd and 144Sm-142Nd systems were obtained. These data confirm that the 144Sm-142Nd system yields an age of 4.56 ± 0.1 Ga, with an initial 143Nd/144Nd of 0.51274 ± 0.00004. The short-lived 144Sm-142Nd system results in a 144Sm/142Nd ratio of 0.2056 ± 0.0001 and an initial 142Nd/144Nd of 0.707 ± 0.0001. All these results confirm that the Sm-Nd systems in these meteorites are consistent with the data (i.e., 20 ± 5 Ma for 144Sm/142Nd and 21 ± 5 Ma for 144Sm/142Nd).

In contrast, the exact time of resolution of the 143Nd/144Nd system presents a more difficult but nonetheless totally consistent picture. In spite of a wide range in Mcr143/144 ratios from 0 (chronic) to ~7 (P), the 144Sm-142Nd and 144Sm-142Nd ratios in all samples measured (chronic, etched bulk, P, and carriers) are the same. Although the typical values are 10–12 ppm, the range in the 144Sm/142Nd values is only 1.1–1.17 units for a variety of Mcr143/144 ratios, with an average difference of 1.1–1.2 ppm. This means that Mcr143/144 = 0.85. When the Mn-Cr system is plotted in a Sm-Nd diagram, the Mcr143/144 ratio of 0.85 is not observed in the Sm-Nd system. This indicates that the Sm-Nd system is consistent with the data (i.e., 20 ± 5 Ma for 144Sm/142Nd and 21 ± 5 Ma for 144Sm/142Nd).


Interplanetary dust and meteorites are widely believed to originate predominantly from the asteroid belt (e.g., [1,2]). However, these two types of matter, which represent distinct mass classes (~10 kg and ~100 kg, respectively), seem to sample different reservoirs, as they are dominated by different types of extraterrestrial matter. The dust is mostly related to the CM-type chondrites [3], which are rare among meteorites that are otherwise dominated by ordinary chondrites (OCs) [2]. To quantify the contribution to the interplanetary dust by OC parent bodies, we have studied 427 particles from the 100–400 μm size fraction of dust recovered from Antarctic ice [4, 303 of which were found to be of extraterrestrial origin. Of these, 41 (~13.5%) are cosmic spherules (CSs), 136 (~44.9%) stoniacromic meteorites (SMCs), 63 (~21.5%) consist of devolatilized phyllosilicates, 11 (~3.5%) consist mainly of phyllosilicates, and 30 (~16.5%) are coarse-grained crystalline MMAs.

Phase compositions of the crystalline MMAs suggest a close relationship between these MMAs and CM-type carbonaceous chondrites (e.g., [3]). Low-temperature reactions and inclusions are both Mg, Cr, and Mn, typical for carbonaceous chondrites (e.g., [5]). Only three crystalline MMAs (<1% of the
total extraterrestrial particle population) have phase compositions that are compatible with derivation from an OC precursor. Particle M6 (~200 μm diameter) has a porphyric texture with olivine (FeO enriched) and low-Ca pyroxene (Fs14, Wo31) in a fine-grained matrix. Micrometeorite Am1 (410 μm long) has also a porphyritic texture with olivines (FeO enriched) set in a fine-grained, clinopyroxene-bearing matrix. Particle M6a (~150 μm long) has a granular texture of intergrown olivine (Fs19,78), low-Ca pyroxene (Fs14,11, Wo30), and plagioclase (An7) with very little intergranular matrix. Minor-element contents of all olivines in these three particles are low (СО < 0.05 wt%, Al2O3 < 0.05 wt%, TiO2 < 0.05 wt%, Cr2O3 < 0.05 wt%, Н2O < 0.02 wt%). The FeO/MnO ratios in olivine vary between 33 and 49, comparable to those of H chondritic olivines [e.g., 6]. Two of these three particles were also analyzed by INAA [3]. Their trace-element abundances match those of ordinary chondrites (e.g., 7).

We conclude that the three particles M6, AM1, and M6a are related to H chondrites, and thus are likely to represent a asteroidal bed contribution to the interplanetary dust population. The abundance of OC-like dust is very low (1%), and up to now limited to H chondritic particles, two equilibrated and one unequilibrated.

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ANGEWIS: A VOLATILE-RICH VARIETY OF ASTEROIDAL BASALT (EXCEPT FOR ALKALIS AND GALLOULIUM). P. H. Warren, A. W. K. Kalllemeyn, 1 Mineralogical Institute, Graduate School of Science, University of Tokyo, Tokyo 113, Japan, 2 Institute of Geophysics, University of California, Los Angeles CA 90024, USA.

Angewis are commonly viewed as extremely volatile depleted, and a related notion is that they formed by differentiation of a volatile-rich material [e.g., 1]. Partial melting experiments repeatedly reproduce the bulk compositions (although not fayalite-rich mineralogy) of anges and Allende as starting material [2], but highly volatile-rich parental materials are difficult to reconcile with isotopic and REE data [3,4]. Mittlefehldt and Lindsley [5] interpreted the low volatile ratios of anges that outgasing, and that the primitive magmas, was more intense on their parent body than on the enstatite parent asteroid.

Of seven elements that (1) have been adequately determined in anges, and (2) are far more volatile (solar nebula 50% condensation T > 600–650 K) than the alkalies (1000–910 K), four are enriched, and none is significantly depleted, in average average compared to average cresset or low-Ti mare basalt (Fig. 1). Gallium, which is of intermediate volatility (850 K), is depleted to roughly the same extent as Na in and K. Rates for As bulk are 881371 [3] are incomplete (Zn, 6 μg/g; Zn, 1 μg/g), not near NAA detection limit, but even based on Anga dos Reis and the two Lewis Cliff anges, this pattern seems firmly established. Apparent gas cressets in As bulk are 881371 [7] also suggest that volatile are far from uniformly depleted.

The key elements known to be depleted, as volatiles, by clearly significant factors in anges vs. cressets or lunar basalt, are alkalies plus Ga. Besides being moderately volatile, a noteworthy characteristic shared by Ga and alkalics (and not shared with elements such as Br, Se, and Zn) is that these elements probably tend to partition into narrow fellspars during gross differentiation of small (low-pressure) bodies. If Ga and alkalics were depleted by a single process starting from "normal" chondritic material, that process would seem to require selective exposure of a fellspars-enriched region (g.e., crust) to extremely high temperature. Ignous crystallization of the anges when the solar system was still extremely young, and apparently 22 Ma after the volatile-depletion process [4]. The data of [5] eliminate *A* as a potential heat source for magmatism. The anges volatile pattern may be the product of heating by an intense, short-lived heat source that melted and partially vaporized the crust of an anges (not necessarily the final anges asteroid), without really affecting the deep interior(s), which later (through mixing and/or magmatism) replenished the anges materials in the anges volatile contents, but not alkalies and Ga. Exogenous heating, as in the often-conjectured (but hard to test) hypothesis that a majorly heated, topographically-enhanced solar luminosity (as in FU Ori stars' epochs), would seem to be required. Lewis Cliff 87051 and As bulk are 881371 are rich in compositionally diverse olivine xenocrysts, and As bulk are 881371 contains a possible FeS xenocryst [7]. These, and the anges' great siderophoric diversity [3], tend to suggest that magmatism and intensely disruptive crusting (with mixing of precursor materials) were contemporaneous. This scenario is admittedly speculative, but the volatile depletion pattern is difficult to rationalize with any other model.


SIDERPHILE TRACE ELEMENTS IN ALLAN HILLS 84001 AND OTHER ACORIDHITES: A TEMPORAL INCREASE OF OXYGEN PUGACITY IN THE MANTLE MANTEL? P. H. Warren, R. A. G. W. Kallemeyn, 1 Institute of Geophysics, University of California, Los Angeles CA 90024, USA, 2 Mineralogical Institute, Graduate School of Science, University of Tokyo, Tokyo 113, Japan.

We have employed neutron activation, including radiometric INAA, in the investigation of N-accretion meteorites such as ALHA 77005, ALHA 84001, and LDW 88136, along with 15 cressets. Our data for 910000 monoextranate cressets confirm previous indications [e.g., 1] that compositionally pristine cressets are generally extremely siderophile poor, although for several of the most extremely siderophile-depleted cressets we find slight enhancements in ReOs (Fig. 1). Our INAA data are the first for highly siderophile elements in polychromic cressets, and show a broad similarity with lunar polychromic breccia.

In general, the data (e.g., Ga/Al = 4.3×10^{-9}) confirm NAc affinity [2] for ALHA 84001. However, siderophile concentrations are, by NAc standards, extraordinarily low: Ni = 5.6 μg/g; (μg/g) Cu = 9.6, Ir = 89, and Re = 10.6 μg/g (μg/g) Cu = 10.6 μg/g. Like terrestrial basalts [1], other siderophile have relatively constant Re, ranging from 28 (Lafayette) to 53 μg/g (ALHA 77005) among seven analyzed meteorites of various types, in which Os ranges from <3 to 4400 μg/g. A plot of Ga vs. ReOs (Fig. 1) shows that ALHA 84001 has 2.8× lower Re than expected for a young NAc of similar composition.

On Earth, Re generally behaves as a mildly incompatible element, whereas Os behaves as a strongly compatible element. A plausible explanation for this discrepancy [1] is that Re is more prone to enter higher oxidation states, such as Re²⁺, which would tend to behave like W²⁺. This model is...