

ISOTOPIC SIGNATURES AND DISTRIBUTION OF NITROGEN AND TRAPPED AND RADIOGENIC XENON IN THE ACAPULCO AND FRO90011 METEORITES; Y. Kim and K. Marti, Department of Chemistry, University of California, San Diego, La Jolla, CA 92093-0317.

**Acapulco metal and silicate show distinct N isotopic signatures. Trapped heavy noble gases are carried by "magnetic" opx and radiogenic  $^{129}\text{Xe}$  excesses are observed in phosphate and in minor surficial phases on metal grains. N and Xe isotopic signatures in FRO90011 do not agree with those observed in Acapulco.**

The Acapulco meteorite is unique in having achondritic texture and chondritic composition. Its mineralogical study shows the record of high temperature ( $1100^\circ\text{C}$ ) recrystallization (1). However, this meteorite shows abundances of volatile elements close to the levels observed in carbonaceous chondrites and concentrations of heavy noble gases comparable to those observed in type 4 ordinary chondrites, not expected for a presumed highly equilibrated object. Nitrogen measurements in bulk Acapulco (2) revealed two different isotopic signatures, in apparent conflict with evidence for a high degree of recrystallization. We have studied N and Xe in separated mineral phases to search for the carriers in order to better understand the formation and thermal history of the Acapulco parent body.

**Nitrogen:** Our nitrogen measurements of metal revealed two distinct isotopic signatures ( $\delta^{15}\text{N} = +20$  and  $-130\text{‰}$ ) (3), indicating that nitrogen carrier phases are not equilibrated. Very light nitrogen ( $\delta^{15}\text{N} \leq -130\text{‰}$ ) was found only in metal, while heavy nitrogen ( $+20\text{‰}$ ) was observed both in silicates and in the low-temperature release from metal. The complex nitrogen release patterns during stepwise heating of metal and during oxidation suggested a heterogeneous distribution of nitrogen in metal. Since Acapulco metal is composed of taenite and kamacite, and taenite is known to have a higher nitrogen solubility than kamacite, we prepared concentrates of low Ni (6.4%) and high Ni ( $>11\%$ ) phases by etching with  $2\text{N H}_2\text{SO}_4$ . Nitrogen measurements show that taenite (28ppm) is enriched in nitrogen relative to kamacite (4.5ppm). Taenite exhibits the signature of very light nitrogen ( $\delta^{15}\text{N} = -150 \pm 3\text{‰}$ ) (Fig. 1) while the isotopic signature of kamacite ( $\delta^{15}\text{N} \sim -130\text{‰}$ ) has a large uncertainty because of a small amount of nitrogen in the concentrate. Heterogeneous distribution of taenite in metal may explain the complex release pattern, but the possibility of a nitrogen-rich phase in the taenite cannot be excluded. Further measurements on an acid residue of taenite shows enrichment of nitrogen ( $>50\text{ppm}$ ) with less negative isotopic signature ( $\delta^{15}\text{N} = -125\text{‰}$ ). The etched taenite, kamacite and the acid residue of taenite released a smaller amount of heavy nitrogen, which is characteristically released at low temperature. This result suggests that the metal initially carried light nitrogen ( $\delta^{15}\text{N} \leq -150\text{‰}$ ), and that the signature of heavy nitrogen is a later overprint due to a partial equilibration of metal with silicates. An unusual feature in the Acapulco mineralogy is the frequent occurrence of swarms of metal blebs in orthopyroxene (opx). The study of these metal blebs may help to better understand the formation history of the Acapulco parent body. Our results show that the signature ( $\delta^{15}\text{N} = -68\text{‰}$ ) of "magnetic" opx (with metal blebs) (Fig. 1) is different from that of opx itself ( $+15\text{‰}$ ). The negative values are observed in the higher temperature steps. Further measurement of a metal-bleb "concentrate" reveals two different nitrogen isotopic signatures ( $\delta^{15}\text{N} = +10$  and  $-120\text{‰}$ ). This result and the fact that metal blebs in opx grains show variable Ni/Fe ratio suggest that metal blebs did not form by the reduction of ferrous iron in opx, but had different origin. The formation of metal blebs and the mechanism of introduction into opx without equilibration of nitrogen components represent important constraints on the history of Acapulco.

**Trapped noble gases:** The heavy noble gases measured in a bulk sample ( $^{132}\text{Xe} = 0.62 \times 10^{-9} \text{ cm}^3 \text{STPg}^{-1}$ ), and in magnetic ( $0.84 \times 10^{-9} \text{ cm}^3 \text{STPg}^{-1}$ ), and nonmagnetic ( $0.16 \times 10^{-9} \text{ cm}^3 \text{STPg}^{-1}$ ) separates were interesting because the enrichment in the magnetic fraction was unexpected, since magnetic fractions of ordinary chondrites are strongly depleted in noble gases. Our results show

that the metal phase and the troilite are very minor carriers while "magnetic" opx carries four times the Xe concentration of the bulk sample ( $2.4 \times 10^{-9} \text{ cm}^3 \text{STPg}^{-1}$ ). Further studies of this material reveal that the noble gases are enriched two times at the site of swarms of metal blebs, but their concentrations are low in metal blebs. The specific carrier of heavy noble gases is not revealed yet. Options are inclusions in addition to metal blebs in opx or microbubbles in opx that may have trapped the gas at the time when the metal was incorporated into opx. We conclude that the trapped heavy noble gas and nitrogen carriers are distinct phases.

**Extinct  $^{129}\text{I}$ :** The records of extinct  $^{129}\text{I}$  in Acapulco yield interesting chronological information. We reported two characteristic release patterns of radiogenic  $^{129}\text{Xe}$  carried by two different carriers (3). Radiogenic  $^{129}\text{Xe}$  released at high temperature ( $\geq 1200^\circ\text{C}$ ) is correlated with fission Xe ( $^{136}\text{Xe}_f = 6 \times 10^{-12} \text{ cm}^3 \text{STPg}^{-1}$ ) from  $^{244}\text{Pu}$  and the carrier is identified as phosphate. The low temperature ( $\leq 600^\circ\text{C}$ )  $^{129}\text{Xe}$  component carried by a minor phase on the metal surface has important implications regarding the thermal history of Acapulco. It appears that this phase contains most of the radiogenic  $^{129}\text{Xe}$ . Concentrates of this phase substantially enriched the  $^{129}\text{Xe}$  ( $730 \times 10^{-12} \text{ cm}^3 \text{STPg}^{-1}$ ) in low-temperature fraction, relative to  $^{129}\text{Xe}$  in bulk Acapulco ( $50 \times 10^{-12} \text{ cm}^3 \text{STPg}^{-1}$ ), but identification is only preliminary. EDS analyses of some metal surfaces show weak peaks of sulfur and chlorine, which may suggest minor S- and/or Cl-bearing compounds. While working for the signature of extinct  $^{129}\text{I}$ , it was found that a hand-picked troilite fraction (13mg) contains significant amounts of  $^{129}\text{Xe}$  ( $100 \times 10^{-12} \text{ cm}^3 \text{STPg}^{-1}$ ). This  $^{129}\text{Xe}$  was released mainly at  $950^\circ\text{C}$ , but the isotopic systematics of troilite Xe indicate a relationship to that discussed above as the low temperature release. On the other hand, troilite does not appear to be the main carrier of  $^{129}\text{Xe}$  since three other small separates of troilite do not release much  $^{129}\text{Xe}$ . Possibly the carrier of  $^{129}\text{Xe}$  is heterogeneously distributed in inclusions in some troilite.

**Antarctic meteorite FRO90011 (Acapulcoite?):** The petrological study of this meteorite suggests a possible relationship to Acapulco because of its high metal content and well-crystallized silicate structure. The isotopic signatures of nitrogen and of Xe were expected to be useful in this regard since Acapulco has a unique nitrogen isotopic signature. Our nitrogen measurements for magnetic ( $\delta^{15}\text{N} = +10\text{‰}$ ) and nonmagnetic ( $\delta^{15}\text{N} \sim 0\text{‰}$ ) separates of FRO90011 are different from those in Acapulco and do not show the signature of light nitrogen. The ratio of radiogenic  $^{129}\text{Xe}$  ( $70 \times 10^{-12} \text{ cm}^3 \text{STPg}^{-1}$ ) and of fission  $^{136}\text{Xe}_f$  ( $< 1 \times 10^{-12} \text{ cm}^3 \text{STPg}^{-1}$ ) differs significantly from those in Acapulco.

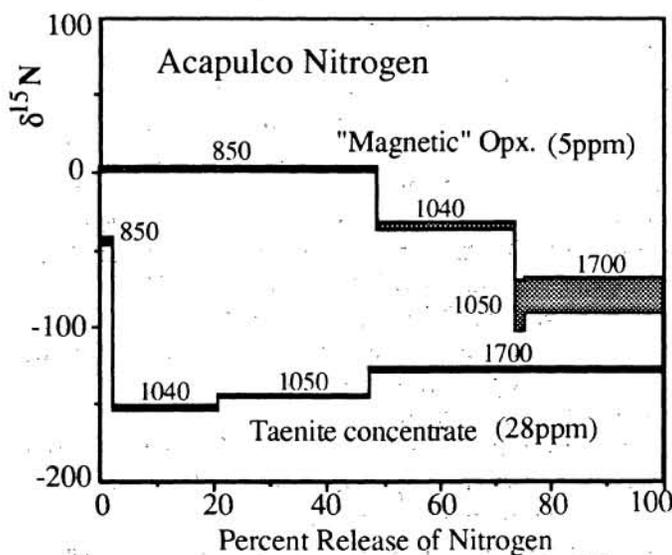


Fig. 1. Isotopic data from step-wise release of nitrogen from Acapulco.

**References:** (1) Palme H., Schultz L., Spettel B., Weber H. W., Wänke H., Michel-Levy C. M. and Lorin J. C. (1981) *Geochim. Cosmochim. Acta* 45, 727-752. (2) Sturgeon G. and Marti K. (1991) *Proc. Lunar Planet. Sci. Conf.* 21th, 523-525. (3) Kim Y., Kim J. S. and Marti K. (1992) *Lunar and Planet. Science* XXIII, 691-692.