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 $^{129}$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 ($1100^\circ$C) recrystallization. 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 revealed two different isotopic signatures, in apparent conflict with evidence of 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 ($^{15}$N= +20 and -130‰) (3), indicating that nitrogen carrier phases are not equilibrated. Very light nitrogen ($^{15}$N= -130‰) was found only in metal, while heavy nitrogen (+20‰) 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 2N H$_2$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 ($^{15}$N= -150± 3‰) (Fig. 1) while the isotopic signature of kamacite ($^{15}$N= -130‰) 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 (>50ppm) with less negative isotopic signature ($^{15}$N= -125‰). 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 ($^{15}$N= -150‰), 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 ($^{15}$N= -68‰) of "magnetic" opx (with metal blebs) (Fig. 1) is different from that of opx itself (+15‰). The negative values are observed in the higher temperature steps. Further measurement of a metal-bleb "concentrate" reveals two different nitrogen isotopic signatures ($^{15}$N= +10 and -120‰). 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 ($^{132}$Xe= 0.62x10^{-9} cm$^3$STPg$^{-1}$), and in magnetic (0.84x10^{-9} cm$^3$STPg$^{-1}$), and nonmagnetic (0.16x10^{-9} cm$^3$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 (2.4x10-9 cm3STPg-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 129I: The records of extinct 129I in Acapulco yield interesting chronological
information. We reported two characteristic release patterns of radiogenic 129Xe carried by two
different carriers (3). Radiogenic 129Xe released at high temperature (> 1200°C) is correlated with
fission Xe (136Xe= 6x10-12 cm3STPg-1) from 244Pu and the carrier is identified as phosphate. The
low temperature (< 600°C) 129Xe 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 129Xe. Concentrates of this phase substantially enriched the 129Xe
(730x10-12 cm3STPg-1) in low-temperature fraction, relative to 129Xe in bulk Acapulco (50x10-12
cm3STPg-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 129I, it was found that a hand-picked troilite fraction
(13mg) contains significant amounts of 129Xe (100x10-12 cm3STPg-1). This 129Xe was released
mainly at 950°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 129Xe since three other small separates of troilite do not release much 129Xe. Possibly
the carrier of 129Xe 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
(815N= +10‰) and nonmagnetic (815N= 0‰) separates of FRO90011 are different from those in
Acapulco and do not show the signature of light nitrogen. The ratio of radiogenic 129Xe (70x10-12
cm3STPg-1) and of fission 136Xe (<1x10-12 cm3STPg-1) differs significantly from those in
Acapulco.

References: (1) Palme H., Schultz L., Spettel B., Weber H. W., Wänke H., Michel-Levy C. M. and
Science XXIII, 691-692.