NWA7533, The CI-Mars Hypothesis and Mars Age Paradox

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Basic Thesis

• CI meteorites are unique
  ➢ 100% water altered
  ➢ No evidence of hypervelocity impact
  ➢ 2% organic matter
• Oxygen Isotopes match Mars meteorites
• NWA 7533 O isotopes indistinguishable from CI
• NWA7533 contains CI material
• **CI-Mars connection is proven (Brandenburg 1996)**
• **CI are 4.5Gyr old (12 meteorites) and thus ratio of young/old Mars meteorites ~1 and Mars age paradox is solved**
Orgueil and NWA 7533

Both are mixed breccias
Agenda

• Comparison of NWA 7533 O isotopes and Cl
• Trapped gases in Cl versus MM (Mars Meteorites)
• Chemical Comparison Cl- MMs
• Morphology Comparisons
• Summary
Cl and MM O isotopes data is now indistinguishable
CI anhydrous grains O isotopes consistent with Mars
NWA 7533 O Isotopes

\[ \Delta^{17}O \% \% \]

\[ \delta^{18}O \% \% \]

NWA 7034/7533 (Martian basaltic breccia)

- MFL: +0.301 ± 0.013
- TFL: -0.072 ± 0.007
- AFL: -0.239 ± 0.007
- EFL: -0.072 ± 0.007
NWA 7533 and Cl O Isotopes
Mars O reservoirs

- Mars has no plate tectonics
- Mars lithosphere and hydrosphere are out of equilibrium as far as $^{17}\Delta$ Oxygen isotopes
- Hydrosphere has higher $^{17}\Delta$ Oxygen than Lithosphere
Nobel Gases

ALH84001 trapped gases match CI

ALH84001 3g/cc separate >1600 C
CI vs MM Trapped Gases

Among the Kr and Xe isotopes (Swindle et al. 1986) have identified what appears to be a highly fractionated AVCC component in Shergotites (Swindle et al. 1986) and Drake et al. (1991) more recently has identified in MM trapped gases two mixing lines in the space of $^{86}\text{Kr}/^{132}\text{Xe}$ and $^{129}\text{Xe}/^{132}\text{Xe}$ abundance ratios. Both mixing lines have the data from Chassigny as an endpoint, indicating that it represents an important trapped gas component in these isotopes. The data from Chassigny, $^{86}\text{Kr}/^{132}\text{Xe}=1.14$ and $^{129}\text{Xe}/^{132}\text{Xe}=1.03$. compares very favorably with data taken from Eugster et al. (1967) which gives $^{86}\text{Kr}/^{132}\text{Xe}=.98$ and $^{129}\text{Xe}/^{132}\text{Xe}=1.05$ for Orgueil indicating that the CI and the MM
Cl vs MM Trapped Gases

Trapped nitrogen, released from the organic portion of the Orgueil meteorite, gives a $\delta^{15}N_{air} = +43$ (Pillinger 1984) whereas nitrogen from EETA79001 glasses ranges from $+90 < \delta^{15}N_{air} < +225$ (McSween 1985). Since Mars atmosphere is believed to have undergone fractionation in time and the Cl are primordial in age, this slightly fractionated nitrogen in Cl’s is consistent with primordial Martian atmosphere.

This Cl-MM hypothesis supported strongly by the discover of an end member nitrogen component in ALH84001, (Murty and Mohapatra 1997) which has of $\delta^{15}N_{air} = +46$ and thus matches that in the Cl almost exactly. They also found a pattern of Xe isotopes that seems to be AVCC, they also found a Kr component in ALH84001 that has an isotopic signature of AVCC Kr
CI vs MM Trapped Gases

In the lighter isotopes, gases trapped in Orgueil organic residues released above 900°C, give average, $^{20}\text{Ne}/^{22}\text{Ne} = 8.5$ and $^{38}\text{Ar}/^{36}\text{Ar} = 0.19$ (Frick and Monoit 1977). These can be compared with values obtained the martian meteorite LEW 88516 released at 1600°C which are: $^{20}\text{Ne}/^{22}\text{Ne} = 0.92$, $^{38}\text{Ar}/^{36}\text{Ar} = 0.56$, (Treiman et al. 1994). Corresponding values for Sherggottite lithologies are in ranges $1 < ^{20}\text{Ne}/^{22}\text{Ne} < 10$ and $.19 < ^{38}\text{Ar}/^{36}\text{Ar} < 1.0$ (Bogard et al. 1984). Atmospheric values for Mars Argon is $^{38}\text{Ar}/^{36}\text{Ar} = 0.18$.
Chromium Isotopes

CI materials match Mars Chromium signature
Chemical Comparisons

- Olivine and Pyroxene grains in CI follow unique Ca-Fe mixing line shared by Chassigny
Intermediate Meteorite Morphologies
Thermally altered CI

• CI parent body could create strong heating

• Beligica 7904, Yamato-86029, 82162, 86720 are thermally metamorphosized CI (by O isotopes) that share a fine grained Olivine rich matrix with NWA7533 and its sisters.
• Ferroan Carbonates in CI match those in ALH84001
Chemical Comparisons

- CI Olivine grains are Ni rich
Morphology

- CI are unique in that they have no evidence of hypervelocity impact (Kerridge and Bunch 1979)
- They contain solar-flare tracked olivine grains, so they were regolith material
- They have to have formed under an atmosphere to suppress hypervelocity impacts
- Thus they must have come from a large body with high gravity and an atmosphere—not a small body like an asteroid or comet— a large body like Mars
Morphology

Lamellar Structure of Clay clasts in CI consistent with formation in strong gravity field
Unique “Embayed” Olivine Grains in the CI

Embayments into Fe-Ca rich (low melting) regions may mark thermal ablation while falling through and atmosphere on the Parent Body (Figure from Kerridge and MacDougall 1976)
Summary and Discussion

• With the discovery of ancient and primitive meteorite NWA7533 and its sisters CI and MM data is indistinguishable

• **CI are 4.5Gyr old (12 meteorites) and thus ratio of young/old Mars meteorites ~1 and Mars age paradox is solved**

• **Unique Absence of hypervelocity impacts means they formed under an atmosphere on Mars**

• CI are 4.5 Billion years old and are 2% organic matter showing early Mars was warm-wet and rich in organics

• **Life findings in ALH84001 and other Mars meteorites are strongly supported**
Thus, We Are Not Alone


