Summary of
“Chemical composition of the Earth ...”
by Claude Allègre

Objective

• Calculation of bulk composition of the Earth for every element.
  – Many volatiles are also siderophile or chalcophile (buried in the core) and their abundance cannot be estimated directly.
  – Composition of the core - what light elements (S, Si, O)?
Introduction

- Meteorites are the oldest objects in the solar system and the closest to the Sun in chemical composition.
- Where does Earth fall with respect to the meteorites?
Approach

- Carbonaceous chondrites represent (undifferentiated) condensates of solar nebula.

- Range in composition due to variable proportions of volatiles (condensation at different temperature).
Fig. 2. MR element ratios in meteorites. These diagrams show that carbonaceous chondrites form a straight line in every diagram with the same relative position CI, CM, CO, CV. In contrast, ordinary chondrites are often outside of these lines. Data are from Wasson and Kallemeyn [51]. Note the position of the Earth for MR is closer to CM than to CI.


- CI, CM, CO, CV always straight line, same relative position.
- Ordinary chondrites are often outside of these lines.
- Use constant ratios to normalize more volatile elements.

- Consider refractory elements, not siderophile nor chalcophile.
- “Primitive” mantle assumed the same as bulk silicate Earth (BSE).
- Earth falls on CC line.
- Fractionation index (volatile, $Q_v$) and (refractory, $Q_r$) for each element (Earth relative to CI and CV).
• From abundance ratios for CV and CI define fractionation factor, $K_v$, for each element.

• $K_v$ determines if $Q_v$ or $Q_r$ is used to calculate abundance ratios.
Choose Pt as refractory and Au as volatile.
Results

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The bulk silicate Earth.
Condensation temperature for the Earth is 1100-1200 K.

Main conclusions

- No “excess” O required to explain density deficit of the core.
- Core: Fe=79%, Ni=4.87%, S=1.21% (assumed), Si= 7^{+8.5}_{-4.5}%, O=5%.
- Lu/Hf is different in the Earth than ordinary chondrite (0.215 instead of 0.172).
Assumptions, questions

- Homogeneous mantle for major elements.
- Binary: refractory or volatile.
- Volatility is independent of speciation or gas composition.
- Are CI and CV analyses accurate enough?
Problems

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Highly volatiles show constant depletion.
Adsorption and/or entrainment process?