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Global approach toward a better understanding of acapulcoites and lodranites: petrological, chemical, isotopic constraints and modeling of the formation processes

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Acapulcoites and lodranites both represent partially differentiated meteorites, intermediate between pristine chondrites on one hand and fully differentiated iron meteorites / achondrites on the other hand. In primitive achondrites, metal differentiation started but did not reach completion due to their low peak temperature and limited degree of partial melting (<5 vol% for acapulcoites and up to 20 vol% for lodranites [1-2]). Both groups display similar oxygen isotope compositions, indicating a close relationship [3]. However, the petrogenetic link between them is still unclear, as well as the physical processes responsible for the aborted differentiation and the precise timing of these events.

Here, we conducted a detailed mineralogical and chemical study of seven acapulcoites and lodranites using optical microscopy, SEM-EDS, EBSD and EPMA. Based on the olivine-chromite and pyroxene-pyroxene thermometers, the equilibrium temperatures could be estimated and the oxygen fugacity at which the meteorites formed has been inferred. The bulk composition of the samples suggests that the precursor was similar to reduced H chondrite material. Considering all data together, we propose a global physical model of partial differentiation that can explain the suite of acapulcoite-lodranite meteorites.

The next step is to unravel the exact timing of differentiation processes. To do so, different chronometers have been used: the ^{182}Hf-^{182}W system to provide information about the last metal-silicate equilibrium, and ^{26}Al-^{26}Mg to date cooling of the silicate subsystem. Besides, the initial amount of ^{60}Fe in the meteorite will also be estimated. Indeed, together with ^{26}Al, ^{60}Fe is also a possible heat source for planetary melting; the abundance and distribution of these two short-lived radionuclides play a major role regarding the extent of differentiation that can be reached at different depths in the parent body. Combining the various radiochronometers and their respective closure temperatures allows to determine the thermal evolution of the meteorite parent body(ies).

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[2] McCoy T., et al. (1997) *GCA* 61:623– 637.

[3] Greenwood R. C., et al. (2017) *Chemie der Erde - Geochemistry* 77:1–43.