MODIFICATION OF THE IRON MINERALOGY, CHEMISTRY AND ISOTOPIC COMPOSITION OF H5 AND L6 ORDINARY CHONDRITES DURING DESERTIC WEATHERING. G. Saunier[1], F. Poitrasson[1], B. Moine[2] and M. Gregoire[3], [1]Laboratoire d'étude des Mécanismes de Transfert en Géologie, Université de Toulouse, Centre National de la Recherche Scientifique, IRD, 14, Avenue Edouard Belin, 31400 Toulouse, France, saunier@lmtg.obs-mip.fr, Franck.Poitrasson@lmtg.obs-mip.fr [2]Département de Géologie, Faculté des Sciences, Université Jean Monnet, 23 Avenue du Docteur P. Michelon, 42023 Saint-Etienne, France, Bertrand.Moine@univ-st-etienne.fr [3]Laboratoire Dynamique Terrestre et Planétaire, CNRS, Université de Toulouse, CNES, 14, Avenue Edouard Belin, 31400 Toulouse, France. gregoire@dtp.obs-mip.fr

Introduction: Meteorites are important witnesses of planet formation processes [1]. A large fraction of the meteorites collected nowadays are found in hot (e.g., Sahara) and cold (e.g., Antarctica) deserts. These rocks were affected by terrestrial weathering related to rain water, atmospheric oxygen, wind, temperature varations and salts from aerosols. Weathering may perturb the mineralogy and geochemistry of meteorites [2-4]. This study focuses on the effects of meteorites weathering from the hot Saharian desert (NWA 4260, NWA 4279, NWA 2258, NWA 2261 and three non official ordinary chondrites) by studying mineralogical modifications, and analyzing the elemental concentration and isotopic composition of iron.

In the last years, multicollector-inductively coupled plasma-mass spectrometry (MC-ICP-MS) has been developed for iron isotope measurements and this technique is now characterized by a good precision, allowing the use of iron isotope signatures to study meteorites and their parent bodies [5-10]. It is however unknown whether terrestrial processing can affect the isotopic signatures of the meteorites recovered from hot deserts. To evaluate this, we have studied the potential effect of weathering on the iron isotope signatures of a suite of L6 and two H5 ordinary chondrites from the Saharian desert, together with associated changes in iron concentration and mineralogy.

Results and discussion:

Effect of weathering on mineralogy. Optical and Scanning Electron Microscopy reveal that weathering is characterized by the oxidation of Fe-Ni metal (Fe^0), sulphides and Fe^{2+} of olivine and pyroxene. This produces Fe-oxides and Fe-oxyhydroxides that replace pre-existing minerals and form veins. Less weathered (W2) meteorites display smaller amount of Fe-oxide/Fe-oxyhydroxide and more sulphides than more weathered chondrites (W4). Sulphides are also found to be more resistant to alteration than Fe-Ni alloys (as previously seen by [11]).

Effect of weathering on geochemistry. Major, trace elements and iron isotopes have been analyzed using ICP-AES (Inductively Coupled Plasma - Atomic Emission Spectrometer), ICP-MS (Inductively Coupled Plasma -Mass Spectrometer) and MC-ICP-MS (Multi Collector - Inductively Coupled Plasma - Mass Spectrometer), respectively, in order to characterize the effect of desertic weathering. Results show an enrichment in Ba and Sr, and a depletion in S which are the three main elements affected by weathering (as also observed by [4], [11]). Barium and Sr enrichment is related to terrestrial contamination and S is released from weathered sulphides.

Effect of weathering on iron isotopes. We observe an increase in Fe isotope composition, with the highest δ^{57}Fe at ~ 0.1‰ for the most weathered meteorites (W4-5) and a lower isotopic ratio (near the δ^{57}Fe of average chondrites: -0.042±0.043‰ [12]) for less weathered ones (W2). A negative correlation between δ^{57}Fe and S is observed, whereas positive relationship link δ^{57}Fe and Ba or Sr contents (Fig. 1). Such Fe isotopic perturbation during weathering are significant because they are of the same order of magnitude to those observed between different type of bulk meteorite samples or between planets because of high temperature processing (e.g., [6], [9-10]).

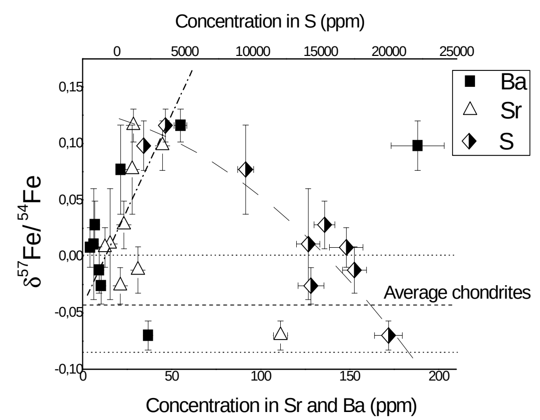

Fig. 1: Relationship of δ^{57}Fe with Sr, Ba and S in bulk H5 and L6 chondrites due to increasing terrestrial weathering. The sample with lowest δ^{57}Fe has high Sr and Ba contents unrelated to weathering because it is only a W2.

A possible explanation is the partial leaching from the meteorite of the isotopically lightest, reduced iron which is released more easily than the ^{57}Fe-rich and oxidized iron (Fe^{3+}). As a result, the more oxidized iron that remains in the meteorite becomes isotopically heavier. This process starts with the oxidation of Fe^{0} and Fe^{2+}, followed by a quantitative precipitation of Fe-oxide/oxyhydroxide, notably in the fractures formed during weathering.

Summary: Weathering affects the mineralogy but also the geochemistry of meteorites from hot desert. Previous studies [11] have shown that meteorites from cold desert have experienced less chemical weathering. They probably represent the best samples, after the falls, to study the primary properties, and the aqueous alteration in the parent body of these primitive meteorites.

References:

[1] Taylor S. R. (2001) *Cambridge University Press*, 460p. [2] Crozaz G. et al. (2003) Geochimica and Cosmochimica Acta 67, 4727-4771. [3] Lee M.R. and Bland P.A. (2004) Geochimica and Cosmochimica Acta 68, 893-916. [4] Bland P.A. et al. (1998) Geochimica and Cosmochimica Acta 18, 3169-3184. [5] Zhu X. K. et al. (2001) Nature 412, 311-313. [6] Poitrasson F. et al. (2005) Earth Planetary Science Letter 234, 253-266. [7] Mullane E. et al. (2005) Earth and Planetary Science Letter 239, 203-218. [8] Khem et al. (2003) Geochimica and Cosmochimica Acta 67, 2879-2891. [9] Schoenberg R. and von Blanckenburg F. (2006) Earth and Planetary Science Letter 252, 342-359. [10] Poitrasson F. et al. (2004) Earth Planetary Science Letter 223, 253-266. [11] Al-Kathiri A. et al. (2005) Meteoritics and Planetary Science 40, 1215-1239. [12] Poitrasson F. et al. (2007) Earth and Planetary Science Letter 256, 484-492.