SYNCHROTRON X-RAY DIFFRACTION AND MÖSSBAUER SPECTROSCOPY STUDIES OF WEATHERING EFFECTS ON ORDINARY CHONDRITES FROM THE ATACAMA DESERT, CHILE.

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This work reports the results obtained by ^{57}Fe Mössbauer spectroscopy (MS) and synchrotron radiation X-ray diffraction (SR-XRD) on fifteen meteorite samples of weathered ordinary chondrites (OC), collected in the San Juan area of the Atacama Desert, northern Chile, that continues previous work done [1] with samples of this densest collection area.

MS is a powerful tool to determine the differences in alteration rate between Fe-bearing phases in a weathered meteorite. The analyses of the spectral area of the primary phases in relation to the total amount of oxidation allow the determination of which phases are most susceptible to weathering. Since the abundance of ferric iron is directly related to the level of terrestrial weathering, the decrease in the spectral area of a primary mineral, should be followed by an increase in a ferric component. In this work the MS results are complemented by SR-XRD experiments performed in the D10A-XRD2 line of the National Synchrotron Light Laboratory (LNLS, Brazil) . The use of synchrotron radiation amplifies the use of XRD since it provides very intense and sharp lines for very crystalline phases. SR-XRD is particularly suited to weathered meteorites which usually have small amounts of many corrosion phases, together with the primary phases. Further, XRD is not restricted to iron contained phases.

The Mössbauer spectra at RT exhibit two Fe^{2+} doublets, associated to olivine and pyroxene, a third Fe^{3+} doublet, corresponding to superparamagnetic oxides and/or oxyhydroxides, and additionally, four sextets due to magnetically ordered phases – troilite, magnetite, kamacite/taenite and large particle goethite. At low temperature (4.2K) the spectra exhibit the same components observed at RT and additionally, a magnetic component (not seen at RT) identified as akaganéite. An increase in the relative areas of goethite and magnetite is also observed and in some samples hematite/maghemite was also detected. The presence of akaganéite and hematite as well as the increase in relative areas, is due to the magnetic splitting at 4.2K of the superparamagnetic Fe^{3+} doublet observed at RT.

The fit of the SR-XRD results was done using the Bruker TOPAS 4.2 © program with the fundamental parameters approach. A standard silicon powder was used to optimize the fundamental parameters. Up to 18 different phases were considered during the Rietveld modelling, Iron was allowed to substitute the magnesium sites of the pyroxene and olivine phases. All the other phases were considered stoichiometric or with constant composition. The goethite amount seems to provide a clear indication for meteoritic weathering. Further the total amount of weathering related phases correlates very well with its Mossbauer equivalent.

References: [1] J. Munayco, P. Munayco, E. M. Valenzuela, J. Gattacceca, P. Rochette, R.B. Scorzelli 2010. Abstract #5035 73th Meteoritical Society Meeting, New York, USA.