Combining µXRF and µCT for the characterization of meteorites: the case of NWA8657 shergottite

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Meteorites are rocks coming from different parts of the solar system, e.g. Moon, Mars, asteroid belt, comets and probably Mercury, which reach the Earth surface after interaction with atmosphere. Their study can provide important information on their native celestial body and consequently on the solar system. Due to their rarity and importance, the use of non-destructive and non-invasive methods is essential for their study, in order to preserve the samples.

X-ray based techniques are very useful in this context since they can provide chemical and microstructural information of the sample without altering it.

In the present work micro X-ray fluorescence spectroscopy (µXRF) and high resolution micro X-ray computed tomography (µCT) were combined in order to characterize meteorites. In particular, a fragment of the Northwest Africa 8657 (NWA8657), classified as shergottite, was investigated. Analysis were led with laboratory equipement.

µCT can distinguish between maskelinite (a plagioclase) and pyroxenes (Figure 1A) which have two different densities (2.7 and 3.9 g/cm^3) and quantify them. Correlating the intensities of Si and Al (Figure 1B) three Al/Si ratios belonging to three different aluminosilicates could be discriminated. The blue group is associated to maskelinite, while the other two groups are connected to pyroxenes. The red group is also associated with a higher concentration of Mg (Figure 1D) which could be imputed to the presence of enstatite while the green one contains only Fe (Figure 1E) and could be recognized as ferrosillite. Other phases like phosphates, jarosite, sulphates and sulphides were also recognized combining the two techniques.

The present approach can be used for the chemical and microstructural characterization of meteorites.

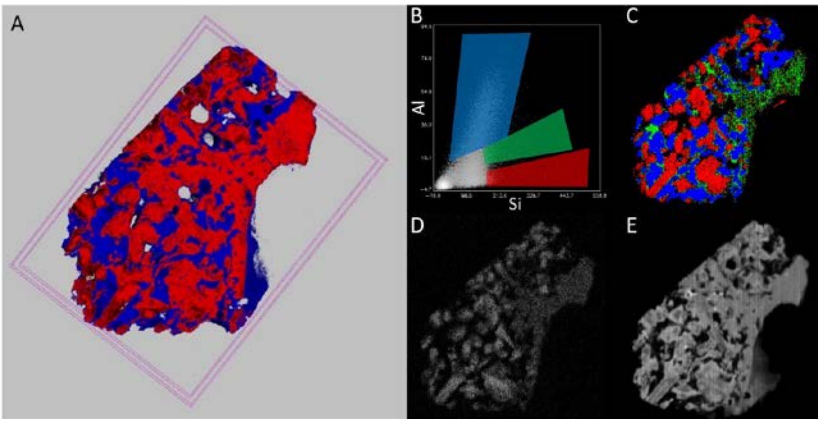

Figure 1: µCT (A) distinguished between maskelinite (blue) and pyroxenes (red). Al/Si scatterplot (B) allowed identifying the distribution (C) of maskelinite (blu), enstatite (red) and ferrosillite (green). Mg (D) and Fe (E) maps allowed recognizing the two pyroxenes.