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Low temperature dehydration and alteration of Cronstedtite

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Abstract

1. Introduction

Serpentine group represents the most abundant hydrated minerals found in Carbonaceous Chondrites (CCs). This group has two significant end-members, the iron rich Serpentines, such as Cronstedtite and Magnesium rich Serpentines such as Antigorite or Lizardite. Several types of Carbonaceous Chondrites contain significant amounts of the iron rich version of the mineral, e.g. Murchison CM2 chondrite contains almost 59% of Cronstedtite by mass [1]. We have shown previously [2] that the Iron and Magnesium end members differ significantly in the onset of dehydration, Cronstedtite having about $\sim 200\,°\mathrm{C}$ lower onset of dehydration (around $\sim 350 - 400\,°\mathrm{C}$) as compared to Antigorite (Mg end member) which starts to dehydrate at about $550\,°\mathrm{C}$ to $600\,°\mathrm{C}$. The low onset of dehydration temperature in Cronstedtite (which is attainable by Near Earth Asteroids during their evolution) along with its abundance in certain CCs, the lack of experimental data on this rare mineral, prompt further study of its behaviour at low temperatures.

Thermo-gravometric and differential scanning calorimetry analyses suggest that within the interesting region of dehydration, two, possibly three, phase changes occur, see Fig. 1.

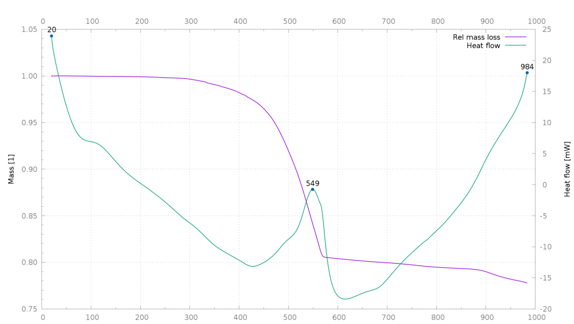

Figure 1: TGA-DSC of a sample of Cronstedtite.

2. Methods

In order to understand the behaviour of Antigorite (Mg end member) and Cronstedtite (Fe end member) at the range of temperatures where dehydration occurs, we employ the following procedure:

1. The sample (usually about $20\,\mathrm{mg}$ to $25\,\mathrm{mg}$, sieved a particular size distribution) is heated to a selected temperature within the interested range in simultaneous TGA-DSC device under Nitrogen atmosphere,

2. X-Ray Diffraction spectra of the sample are taken,

3. visible and near infrared diffuse reflectance spectra are taken.

The process is then repeated with a fresh sample and higher temperature. The obtained data spectral data for Cronstedtite at 2 temperatures can be seen in Fig. 2.

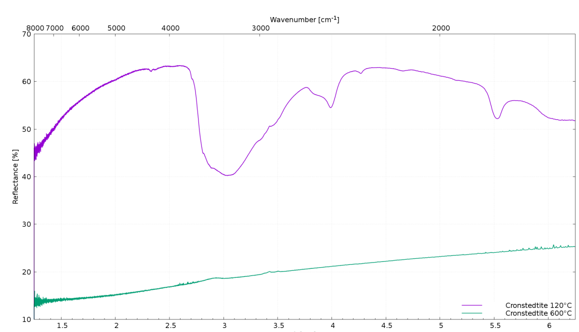

Figure 2: Dehydration of Cronstedtite observed in its reflectance spectra.

3. Preliminary results

We have obtained thermal evolution of Antigorite as can be seen in the evolution of its spectrum in Fig. 3 and its XRD pattern in Fig. 4

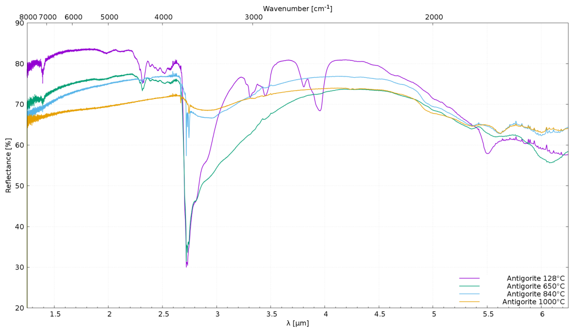

Figure 3: Dehydration of Antigorite observed in its reflectance spectra.

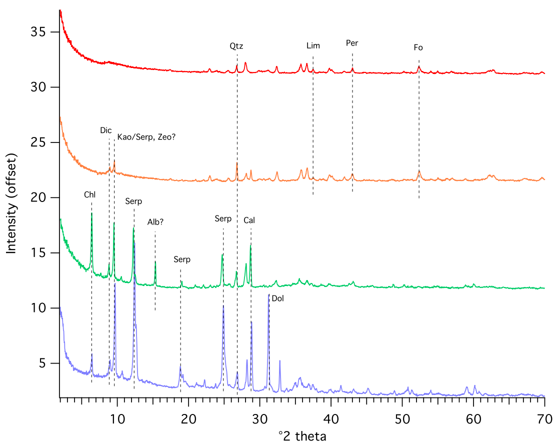

Figure 4: Dehydration of Antigorite observed in its XRD spectra.

4. Summary and Conclusions

The poster presented at EPSC-DPS Joint Meeting 2019 will present data for Cronstedtite which undergoes dehydration at significantly lower temperatures that are attainable by Near Earth Asteroids. The data will contain the evolution in visible and near infrared spectra as well as the evolution of mineralogy from the X-Ray diffraction pattern.

References

[1] Bland, P. A., Cressey, G., and Menzies, O. N. (2004).: Modal mineralogy of carbonaceous chondrites by X-ray diffraction and Mössbauer spectroscopy. Meteoritics and Planetary Science, 39:3–16.

[2] Pohl, L., Britt, D. T. (2017): Temperature and rate of dehydration of major constituents of carbonaceous chondrites under vacuum conditions, American Astronomical Society, DPS meeting #49, id.208.01