EPSC Abstracts
Vol. 9, EPSC2014-378-1, 2014
European Planetary Science Congress 2014


# Fresh Exposures of Fe-Allophane/Opal in Association with Channels and Debris Aprons in Coprates Chasma, Mars

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## Abstract

We have discovered relatively fresh deposits of a hydrated, amorphous material resembling Fe-rich allophane or opal along the wallrock slopes in Coprates Chasma, Mars (Fig. 1). The deposits appear similar to numerous mass wasting flows and debris aprons visible along the wallrock slopes. It is only with the aid of CRISM visible and near-infrared reflectance spectral data that these deposits appear distinct. Spectra extracted from the deposits exhibit broad absorptions at 1.42, 1.94, and ~2.25 µm. These broad absorptions and peaks shifted to longer wavelengths relative to spectra of allophane and opal are most consistent with Fe-allophane/opal produced synthetically in the laboratory. The three absorptions, especially the 1.4 µm, are very strong relative to most martian hydrated spectra, suggesting high water content that is relatively fresh and has not altered or lost water since formation/exposure. The confinement and concentration of Fe-allophane/opal into channels suggests that there was movement downslope, but the channels may have formed previously and could have been used as a conduit by the younger Fe-allophane/opal debris.

## 1. Introduction

### 1.1 CRISM Spectral Observations

A CRISM spectrum taken from one of the Fe-bearing deposits at Coprates is shown in Fig. 2. Laboratory spectra of selected minerals including synthetic allophane have an absorption between 1.38-1.40 µm due to the OH stretching overtone, a broad $H_2O$ band near 1.92 µm, and an OH combination (stretch+bend) band near 2.19 µm (Fig. 2). The CRISM spectrum exhibits broad absorptions centered around 1.42, 1.94, and ~2.25 µm. These broad absorptions and peaks shifted to longer wavelengths relative to spectra of allophane and opal are most consistent with a Fe-allophane or Fe-opal synthesized

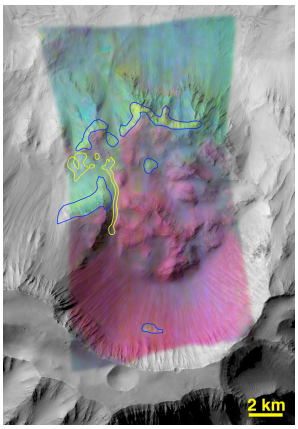


**Figure 1.** CTX image with CRISM spectral parameters overlain in color (red is olivine index, green is band depth at 1.9 µm, blue is doublet at 2.2 µm). The Fe-allophane/opal deposits are outlined in yellow, while the smectite exposures are mapped by blue lines.

in the laboratory [1,2]. The three absorptions, especially the 1.4 µm band, are very strong relative to most martian spectra of hydrated regions, suggesting high water content that is relatively fresh and has not altered or lost water since formation/exposure.

In addition to the Fe-allophane/opal deposits, there are exposures of clays identified in a CRISM spectrum that correspond to discreet layers within the wallrock at Coprates Chasma. CRISM spectra extracted from these bedrock layers have a weak absorption at ~1.4 and 2.31 µm, and a strong absorption at 1.92 µm, consistent with Fe/Mg-smectites or chlorite. There are several exposures of smectites at different elevations within the wallrock.

## 1.2 HiRISE Morphologic Observations

The Fe-allophane/opal corresponds to debris and debris aprons along the wallrock slopes in an alcove where a landslide formed (Fig. 1). There are several deposits and channels associated with the Fe-allophane/opal material, suggesting either a long duration flow that changed its course over time, or multiple smaller events. Alternatively, the channels and aprons may be older features, while the Fe-allophane/opal represents a younger superimposed deposit. This hypothesis is supported by the whispy bright nature of the Fe-allophane/opal deposits, perhaps indicative of a thin mantle of debris covering pre-existing terrain. The confinement and concentration of Fe-allophane/opal into channels suggests that there was movement downslope, but that the channels may have formed previously and could have been used as a conduit by the younger Fe-allophane/opal debris.

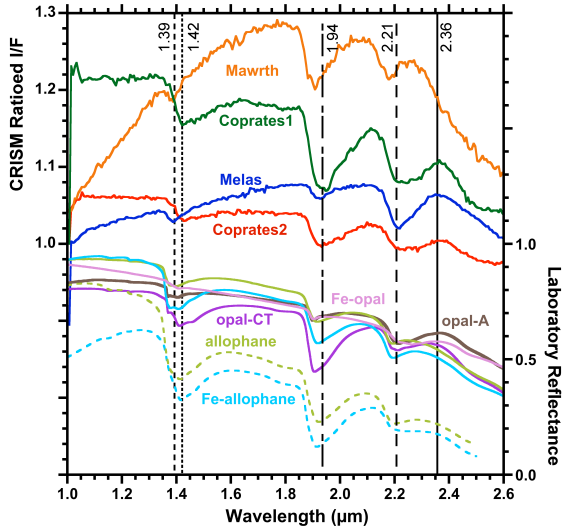


**Figure 2**: CRISM spectra taken from two Fe-hydrated deposits in Coprates (HRLA8F6). A spectrum from Mawrth (FRT863, allophane) and Melas Chasma (FRT44AC, opal) have been rescaled so that all bands are of similar strength and can be compared to those from Coprates. Also shown are laboratory spectra of opal, synthetic allophane [2], and synthetic allophane and opal with 10% of the Al replaced by Fe (Fe-allophane, Fe-opal) [2], as well as these same synthetic allophanes measured under hydrated conditions (dashed lines).

# 2. Results

Allophane and opal are amorphous or poorly crystalline hydrous aluminum silicate material [e.g. 3]. The CRISM spectra are best matched to lab spectra of hydrated, amorphous material containing Al, Si and Fe. The martian deposits must be fresh because of their strong hydration features since any Fe-allophane/opal would have dehydrated or altered if exposed at the surface for an extensive length of time. Crater age dating of the two larger deposits yields ages of 50-100 My, consistent with a young exposure time. Either the Fe-allophane/opal represents an older material already contained within the wallrock that was exposed during collapse associated with the landslide event, or it represents a younger material formed during more recent aqueous activity. There is no evidence for Fe-allophane/opal within the wallrock, although there is a considerable amount of dark debris shedding along the wallrock slopes that could be covering up any outcrops.

# 3. Summary and Conclusions

Allophane has been identified in clay-bearing regions on Mars using TES [4]. Nanophase aluminosilicates have also been identified at Mawrth Vallis on Mars using CRISM data [5]. Curiosity instruments have detected an amorphous phase in the soils that may contain allophane [6,7], suggesting allophane may be a common component of clay-bearing regions on Mars. Hence, understanding the orbital detections of Fe-allophane/opal could have important implications for aqueous alteration across the surface of Mars.

# References


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