GLOBAL MAPPING OF MARS WITH CRISM SUMMARY PRODUCTS O.M. Kamps[1] (o.m.kamps@utwente.nl), R.D. Hewson[1], F.J.A. van Ruitenbeek[1], F.D. van der Meer[1], [1]University of Twente, ITC (Faculty of Geo-information Science and Earth Observation)

Introduction: The global composition of Mars has been studied with many instruments. So far, in the visible-/near-infrared wavelength range, the global mineral composition of Mars has only been studied with the OMEGA instrument. Here, the CRISM data, measured in mapping mode, is used for the first time to study the global surface composition and define surface types.

This study presents a statistical approach where the summary products of Pelkey et al. (2007) [1] have been used. With unsupervised clustering it is examined what global compositional variance can be described with this dataset. Besides defining surface types, this methodology allowed us to evaluate and aid the interpretation of the summary products.

Method: The summary products were downscaled to 5*5° pixels by averaging the values for each pixel. The downscaled data was then used for hierarchical cluster analysis.

With a tree diagram from the hierarchical cluster results we can examine how the surface type clusters are related. Statistical analysis showed that 20 clusters described most of the variance of the global CRISM data, which can be divided in 5 main groups.

Principal component analysis was used to test how the surface type clusters and summary products relate to each other.

Variables

Besides clustering pixels, the summary products were also clustered to see how these relate to each other. This analysis is supported by calculating the correlation coefficients between all summary products. Also, averaged values of the dust coverage [1] and digital elevation have been included in the correlation coefficients to see how these relate to the summary products. It was found that 7 summary products have a high effect (correlation coefficient > 0.8) with the elevation. It was thought that these relate more with the atmosphere than surface mineralogy, and are therefore excluded from further analysis.

The same summary products were also calculated for laboratory spectra. Different types of mineralogy have been included to validate how the minerals and summary products relate to each other.

Results: Figure 1 presents the results of the cluster

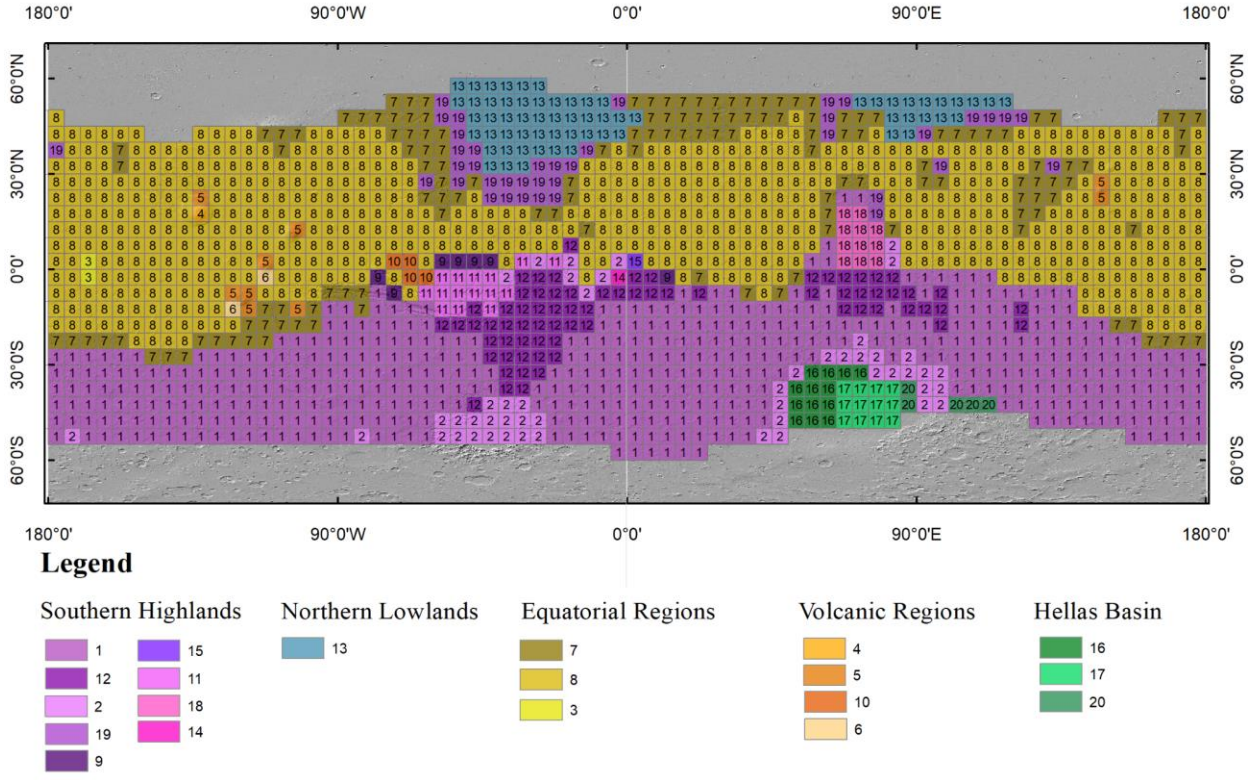

Fig 1: *Defined surface types based on hierarchical cluster analysis of averaged CRISM summary products*

analysis performed with 26 of the 33 summary products. Seven summary products were considered as atmospheric related and omitted from this map product (e.g. BDCARB, BD3000, ICER2, BD2290, BD2100, BD1750, BD1435).

It was found that the 20 clusters can be divided into 5 major units (see Figure 1 and 2). The five different major units are named, (1) southern highlands (2) northern lowlands (3) equatorial region (4) volcanic regions (5) Hellas basin.

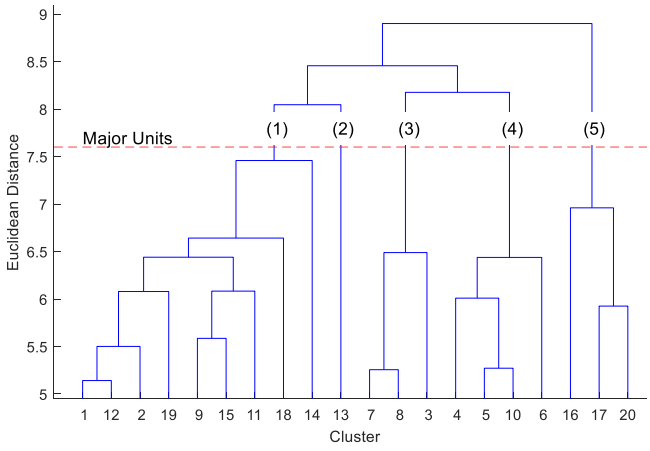

Fig 2: tree-diagram of the defined surface type based on hierarchical cluster analysis.

Discussion: The processed global CRISM data was able to classify most of the apparent geological features on Mars. The major units will be discussed below.

The northern lowlands distinguishes itself with high values for the summary product ISLOPE and lower values for the pyroxene indices. Cluster 13, northern lowlands, shows a similar distribution as mapped as surface type 2 by Bandfield et al. (2000) [4]. This cluster is defined by low values for pyroxene summary products and high values for the summary product ISLOPE1. The ISLOPE1 is interpreted before as ferric coating, but this is not supported by the spectra from the spectral libraries.

The northern lowlands show opposite composition of the southern highland. The southern highlands are characterized by higher values for the summary products BDI1000VIS, BDI2000, BD860, BD920, LCPINDEX, HCPINDEX. These are all summary products that have high values for pyroxene. This suggests that the southern highlands is characterized by higher concentration of mafic minerals, also indicated by the higher olivine index.. Interesting is cluster 19, which is located in the lowlands on Mars, but shows most similarity with the composition of the highlands of Mars. This results indicates that there is a clear boundary between the major compositional differences on Mars, characterized by differences in mafic mineralogy.

The other main compositional difference is found in the equatorial regions, which are interpreted as dust covered regions [2]. Most of the summary products related to this region (R770, RBR, BD530, RPEAK1, IRAC, BD1500, CINDEX) are described as dust summary products [1,3] and show high correlation coeffiients with the dust coverage index [2]. Away from the equator the dust content appears to decrease (Cluster 7), and composition is more similar to the adjacent surface types. The summary products BDI1000VIS and BDI2000 show high negative correlation coefficiencts with the dust product. Earlier studies have indicated that these products describe Fe-mineralogy, but this is not supported with the laboratory spectral analysis here nor its spatial variance on Mars. BD1500 and CINDEX show high relation with the dust regions and might be possible to derive new insights into the composition of the dust. Both products are hydrated products. This suggests that the dust may include a hydrated component such as salt or clay.

The major units, Volcanic regions and Hellas Basin, are not yet related with a mineralogical compositon. The products that defined these surface types seem to have outliers in these regions (e.g. BD3200, SINDEX, BD1500, SH600, ICER1 and BDI2000). It is not clear yet what defined these outliers, but it is thought that it relates with atmospheric conditions around these extreme elevated regions.

Conclusions: This study has shown that the multispectral summary products are useful for characterizing surface types on Mars. It also gave new insights in the relation between the summary product and the mineralogy. Regarding the surface types, a difference between the northern and southern hemisphere was observed and found to be related with differences inmafic mineralogy. A clear boundary in the northern hemisphere was noticed between the different compositions. Around the equator a large region was identified as dust covered. The relation with the summary products indicates that there is a hydrated component in the dusts, possibly related to clay or salts.

References: [1] Pelkey, S.M. et al. (2007) *JGR, 112*, E08S14 [2] Ruff, S.W. et al. (2002), *JGR, 107*, E12 [3] Viviano-Beck, C.E. et al. (2014) *JGR: Planets, 119*, 1403-1431 [4] Bandfield, J.L. et al. (2000), *Science, 287*, 1626-1630