G-MODE CLASSIFICATION OF MARTIAN INFRARED SPECTRAL DATA FROM ISM-PHOBOS 2. *A. Coradini and P. Cerroni, IAS-Reparto di Planetologia,Viale dell'Universita' 11,Roma, Italy, O. Forni and J.P.Bibring, IAS- Universite' Paris Sud, Orsay, France, and A. I. Gavrishin, Polytechnichesky Institut, Novocherkassk, URSS.*

The infrared spectra of Mars obtained from the ISM instrument on board the PHOBOS 2 mission have been analyzed by means of G-mode, a powerful statistical multifactorial method (1). The ISM data are typically multivariate; in fact, in each mapped area, for a given spatial pixel the spectrum is measured in 128 channels in the wavelength range from 0.76 to 3.14 microns (2,3). The spectra of the selected areas are arranged in a matrix NxM, where N is the number of "samples' (space pixels) and M the number of "variables" (spectrum channels). The G-mode algorithm allows "homogeneous" classes to be identified on the basis of an iterative procedure. The classifications is based on an hypothesis test: the critical value is represented in terms of Q, the security value, i. e. the probability that a sample belonging to a given class is not assigned to it by the classification. For example, a Q value of 2.58 corresponds to a probability of 99.5, while for Q=3.00 it is of 99.8; thus, a smaller Q value will give a more detailed classification.

The main advantages of this method can be thus summarized: 1) the method represents a synthetic way to represent the data; 2) it allows to search for a special spectral signature within an otherwise homogeneous group; 3) automatical mapping of mineralogically different provinces could be performed.

We will report here on the results of the application of the G-mode classification method to two test regions from ISM Mars spectral data: the region of Olympus Mons, and the region of one of the central canyons of Valles Marineris, Melas Chasma. The data have been classified on the basis of 50 spectral variables, from 0.761 to 2.470 microns (array 0 of the ISM instrument); the spectral channels ranging from 2.514 to 3.15 microns have not been used for the classification because they were found to be exceedingly noisy.

The most important features of the spectrum have been automatically identified by the G-mode classification as follows: 1) Atmospheric effects; 2) Albedo effects; 3) Slope effects (and overall shape of the spectrum).

The spectral signature of the atmosphere, and in particular the depth of the 2 microns CO2 band, was found to be the main spectral feature. This was evidenced in our results by the classification of the Mons Olympus region over the whole spectrum, where seven "homogeneous" classes were identified by the G-mode classification, differing one from the other mainly for the depth of the 2 microns CO2 band, and reflecting mainly the altimetry of the region. As a second step, we have "removed" the atmosphere from our classification by excluding from our set of variables the spectral channels where the main atmospheric spectral signatures are expected; the excluded variables ranged from 1.398 to 1.463 microns and from 1.914 to 2.124 microns. The classifications was then carried out on the basis of the remaining variables, and the "homogeneous" classes thus found reflected mainly albedo differences. The albedo maps thus obtained where found to be very detailed , and the similarity *with the geologic maps of the regions was found to be striking: different geologic units were identified by the G-mode as different classes with a high degree of precision. Finally, the albedo effects were removed by normalizing all spectral data to a given spectral channel, which could be safely assumed to be away from absorption features . The classification carried out on the data thus normalized was found to reflect mainly similarity in slope and overall shape of the spectra. It should be pointed out that subclassification is possible with this method; thus, the identification of groups characterized by spectral features of interest for mineralogical identification purposes could be done automatically by subclassification of the homogeneous classes previously identified.*

Further potentialities of this method include: 1) identification of relationships among variables , and possible removal of redundant variables; 2) identification of relationships among different classes; 3) subclassification; 4) possibility of adding new samples to the existing classification, thus making it possible to carry out comparisons among different areas.

In conclusion, we would like to stress out the the G-mode statistical method is a very powerful tool to carry out automatically mineralogical mapping from spectral features measured by ISM. This will be applied extensively to ISM data in the near future.

(1) A Coradini et al., A FORTRAN V program for a new classification technique: the G-mode central method. Computers and Geosciences 3, 85 - 105. (2) Bibring et al.,1989. First results of the ISM experiment . Nature 341, 591 - 592. (3) Bibring et al., 1990. ISM observations of Mars and Phobos: first results. Proc. 20th Lunar and Planet. Sci. Conf. 461 - 471.