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Synthetic and natural plagioclases: iron variations and its influence on VNIR reflectance spectra

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Besides being one of the most important rock-forming phases, plagioclase (pl) is a common surface mineral in several Solar System bodies. In particular, pl is present in meteorites and lunar samples, both in lunar Highland, where it is the dominant phase, and Maria samples. Moreover, pl has been detected in Martian meteorites, as well as in HEDs.

In visible and near-infrared (VNIR) reflectance spectroscopy this phase is characterized by a crystal field (C.F.) absorption band in iron-bearing samples. In particular, Burns (1993) summarized the electronic absorptions due to iron, pointing out: 1) a broad absorption around 1.25 μm related to a C.F. transition due to Fe^{2+} replacing Ca^{2+} in seven-fold coordinated sites; 2) narrow absorptions around 0.4 μm related to tetrahedrally coordinated Fe^{3+} ions replacing Al in the tetrahedral sites.

A better understanding of the spectral properties of Fe^{2+}-pl can be an important tool to investigate the spectral influence of pl in regolith material in which it can be mixed with variable amount of other components with variable abundance. This goal can be reached working on synthetic pl with variable FeO and An contents, which must be well characterized to be sure about the attribution of absorption bands seen in reflectance spectra, as well as working on well characterized (in term of An, iron amount and Fe^{2+}/Fe^{3+}) terrestrial pl.

Future rover mission will have onboard hyperspectral instrument working in the VNIR with relative high spatial resolution and, so, with the possibility of measured pl crystals. For this reason, working more in detail on iron bearing plagioclase can be an important task.

Here, we present our results on synthetic An90 mol% pl with different iron contents (0, 0.5 and 1.0 FeO wt%) with the aim to investigate the effects of iron substitution on the VNIR spectra of pl. Reagent-grade oxides and carbonates reactants used as starting materials were thoroughly mixed to ensure homogeneity. Each experimental charge weighed about 200 mg. All the experiments have been carried out in a Deltech vertical gas-mixing ($CO - CO_2$) quenching furnace equipped with an oxygen fugacity probe. Temperatures were in the 1395 – 1580 ˚C range and run duration varied from 15 min to 48 hours. The synthesis procedure envisaged two stages: 1) preparation of a glass from the starting material at high temperature (1550 or 1580 ˚C); 2) annealing at lower T (1395 ˚C).

The produced pl were grinded and sieved at about $<$100 μm, VNIR reflectance and EXAFS spectra have been acquired to define the reflectance spectra and the Fe^{2+}/Fe^{3+} ratio on each experiment. Moreover, the obtained products were characterized by several techniques such as optical microscopy, XRD, SEM, EMPA, to assess the pl-crystallinity and its chemical composition.

Spectra collected on synthetic samples are compared with those of natural pl, and the broad 1.25gμm C.F. absorption parameters have been related to Fe^{2+} abundance and Fe^{2+}/Fe^{3+} ratio.

Reference: Burns, R.G., 1993. Mineralogical Applications of Crystal Field Theory. Cambridge University Press, 551 pp.