ARE THERE PYROXENES ON A-ASTEROID SURFACES? L. Golubeva and D. Shestopalov. Shemakha Astrophysical Observatory, Shemakha, Azerbaijan, AZ-3243 (land@azdata.net).

Introduction: To date, there exist no consensus of opinion on A-asteroid surface mineralogy. Some investigators believe olivine to be the predominant silicate mineral of A-asteroids [1,2,3]. “Reddish” spectra of these bodies could be explained by either the presence of an abundant red-sloped phase (such as meteoritic iron) [1] or maturation of a surface olivine under the influence of space weathering [2]. The others, simulating the spectra of intimate mixtures of minerals without any weathering effects, suppose that there may be more pyroxene than olivine on the A-asteroid surfaces [4]. As it is shown in [5] some angrite meteorites, containing both pyroxene (fassaite) and olivine (Px/Ol ~ 1), have reflectance spectra similar to A-asteroid spectra.

We see that probable mineralogy of the A-asteroid surfaces varies in terms of the meteoritics from olivine achondrites through pallasites (olivine-metal enriched surface) to angrites. Such a disagreement arises owing to the fact that the strong spectral bands near 950 – 1000 nm in the spectra of pyroxenes and olivines are essentially covered and, in addition, some Ca-rich clinopyroxene spectra do not have the second absorption band near 1900 nm. Thus, the presence of the olivine-like feature near 1000 nm and the absence of the absorption near 1900 nm in the spectra of A-asteroids fail to prove yet the absence of pyroxites on their surfaces. Is there another evidence of pyroxene in the A-asteroid spectra?

500-nm absorption feature in the spectra of olivine-pyroxene mixture: The spin-forbidden bands near 495 and 505 nm, both attributed to Fe$^{2+}$, are situated, correspondingly, in olivine and pyroxene spectra. Fig.1 shows the 500-nm absorption (where a linear continuum has been divided out) in the reflectance spectra of intimate olivine-pyroxene mixture as well as the absorption bands in the spectra of the mineral components. The spectra of the mixture were calculated with the known end-member spectra from [6] by the theory developed in [7]. As is clear from the figure, the olivine and pyroxene bands partially overlap in olivine-pyroxene mixture spectra, but minima themselves are separated. Note that strength of the 500-nm feature is always less than that of the olivine band and is the complicated function of mineral grain sizes. Therefore, neither depth of minima, nor ratio of these depths determines the mineral content of the mixture. Only the separated minima of the 500-nm absorption feature allow determining the presence of olivine and pyroxene on a remote surface.

A-asteroid reflectance spectra: The spectra of the A-type asteroids 289 Nenetta, 446 Aeternitas, and 863 Bencoela from SMASS1 [8] were optimally smoothed by the method described in [9] to pick out the faint absorption feature near 500 nm. The observed and smoothed asteroid reflectance spectra are shown in Fig.2. The 500-nm absorption feature is well determined in Nenetta and Aeternitas spectra and is within the errors in Bencoela spectrum. As it is shown in [10], the reflectance spectra of olivine powders are very sensitive to grain size of the samples. Spectral albedo increases and strength of all absorption features decreases when grain size decreasing. IRAS albedo of Bencoela is 0.6 and two and half times as large than that of Nenetta and Aeternitas (http://pdsspn.astro.umd.edu). It is the grain size effect that could appear to explain the very small strength of the 500-nm feature in Bencoela spectrum.

Figs.3 and 4 show the 500-nm absorption feature in Nenetta and Aeternitas spectra. The separated minima near 495 and 505 nm clearly indicate pyroxene and olivine on these asteroid surfaces. One may suppose that the third minimum of the Aeternitas absorption feature is attributed to Fe$^{2+}$ in the M2 site of pyroxene structure. But this supposition requires the additional testing owing to relatively large errors in the minimum region.

So we give a favorable answer to a question about the presence of pyroxenes on A-asteroids Nenetta and Aeternitas. Taking into consideration that spectra of all three considered asteroids are very similar in the range from 400 to 900 nm, this conclusion appears to be also justified for Bencoela.

In addition to the obtained result we can approximately estimate the composition of the asteroid olivines (in terms of forsterite content) using the properties of the 495-nm absorption band in the olivine spectra [11]. For this aim the 500-nm feature was represented as sum of Gauss-like components, which are also shown in Figs.3 and 4. The contours of these components do not present, of course, the contours of the real olivine and pyroxene absorption bands. Such approximation was used to estimate more carefully position of minima of the compound 500-nm feature. The 500-nm feature minimum, which belongs to olivine, is located at 495.5 nm and 496.7 nm in the spectra of Nenetta and Aeternitas, respectively. Thus olivines of these A-asteroids contain approximately (60 ± 10)% and (50 ± 10)% forsterite.

Fig. 1. The 505- and 495-nm absorption bands in the reflectance spectra of pyroxene and olivine, respectively, as well as the 500-nm absorption feature in the calculated reflectance spectra of the intimate mixture of these minerals. The curves are shifted for clarity.

Fig. 2. The observed and smoothed spectra of A-asteroids. The initial spectra are taken from SMASS1. Optimal running box size is indicated in the legend. The curves are shifted for clarity.

Fig. 3. The 500-nm absorption feature in the optimally smoothed spectrum of 289 Nenetta. The spectral components, forming the feature, are shifted for clarity.

Fig. 4. The 500-nm absorption feature in the optimally smoothed spectrum of 446 Aeternitas. The spectral components, forming the feature, are shifted for clarity.