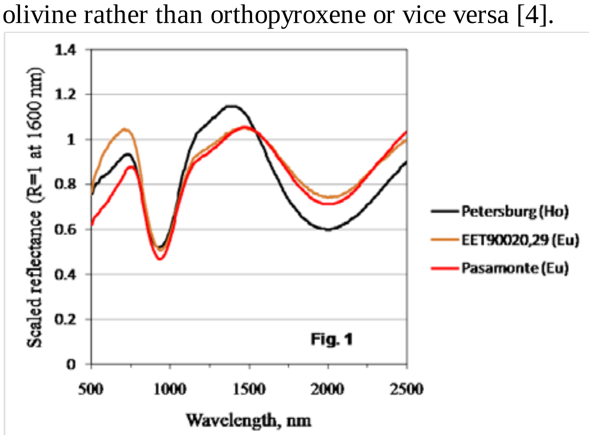
REMOTE SENSING OLIVINE IN PYROXENE-BEARING TARGETS: THE CASE OF V-TYPE ASTEROIDS. D.I. Shestopalov[1], L.F. Golubeva[1], E.A. Cloutis[2]. [1]Shemakha Astrophysical Observatory, Shemakha AZ-3243 Azerbaijan, (shestopalov_d@mail.ru), (lara_golubeva@mail.ru), [2]University of Winnipeg, 515 Portage Avenue, Winnipeg, MB, Canada R3B 2E9, (e.cloutis@uwinnipeg.ca).

Introduction: How much olivine is present on the surface of asteroid Vesta? The first quantitative estimates of olivine content in Vesta's units obtained before Dawn's era give the value of order of several volume percent [1]. Dawn's VIR and FC instruments have found local olivine-rich deposits at Bellicia and Arruntia craters and also at several areas in the eastern hemisphere but could not detect the mineral in the huge Rheasilvia impact basin [2, 3 and references therein]. The latter is an unexpected result since the mantle of differentiated Vesta is believed to contain significant (> 50 %) olivine [4], and the excavation depth of Rheasilvia is more than the probable thickness of Vesta's basaltic crust. It seems unlikely that this enormous impact would not have exposed mantle material [4]. Apparent absence of olivine in Rheasilvia basin may result from strong dilution of olivine-bearing mantle material due to permanent impact mixing with pyroxene-rich crustal rocks.

Some V-type asteroids, dynamically linked with Vesta, may represent fragments of Vesta's mantle and be enriched in olivine. Indeed, several vestoids contain olivine on their surface of order of ten percent [5]. The reliable estimate of the modal proportion of olivine on Vesta and vestoids may be a key to the problem, whether the Vestan upper mantle consists basically of olivine rather than orthopyroxene or vice versa [4].

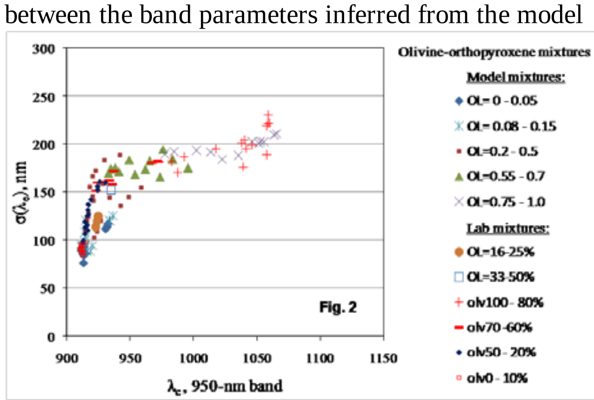


The challenge is to distinguish olivine by the spectra of olivine/pyroxene mixtures at low olivine abundance (~ 10–20 %). Figure 1 illustrates the spectra of the olivine-free howardite and eucrites. The eucrite spectra, nevertheless, can be easily confused with olivine-containing material.

Here we study the properties of reflectance spectra to detect olivine at its low content in mixtures, which are similar in their composition to the regoliths of Vesta and vestoids. It is difficult to produce a required quantity of powdered meteorite samples for mixing with olivines of various compositions. Therefore, we use theory [6] to compute the reflectance spectra of the intimate mixtures of HED meteorites and olivines.

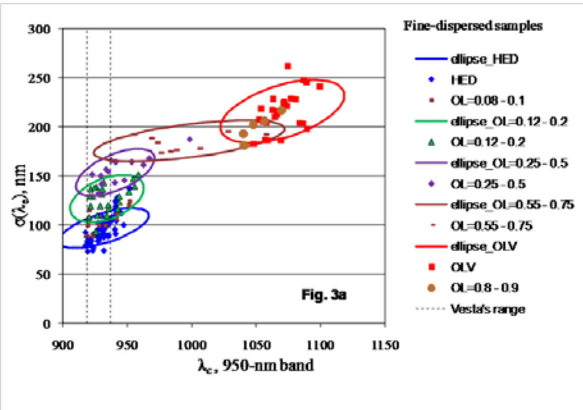
900-nm absorption band parameters: The position of this band in the spectra of the above mixtures is well known to be shifted towards longer wavelengths, as olivine content increases. So, we concentrated on the variation of the shape of 900-nm absorption band after continuum being removed in the spectra of HED–olivine or olivine–orthopyroxene mixtures. The shape of the absorption band is defined by the following parameters: the coefficients of skewness and kurtosis, FWHM, and the variance, $\sigma^2(\lambda_e)$, of the band center position, λ_e. Only the last parameter proves to be useful for our task.

Method: Figure 2 shows the spectral characteristics of olivine-orthopyroxene mixtures on the $\sigma(\lambda_e)$ – λ_c plot, where λ_c is the position of maximum absorption in the spectral band after removing a linear continuum. We refer an interested reader to the paper [7] to find the equations for the band parameters $\sigma(\lambda_e)$, λ_e , and λ_c. As is seen from Fig. 2, there is a satisfactory fit between the band parameters inferred from the model



and laboratory spectra of these binary mixtures. The initial spectra were taken from RELAB, USGS, and HOSERLab databases. On a close examination of the data, the grain size of the samples was found to affect $\sigma(\lambda_e)$ parameter. Therefore, on analogy with asteroid regolith we used fine-dispersed samples with the grain sizes of ~ 20 – 70 μm to calculate the spectra of the binary mixtures of HED meteorites and olivines.

Results: Figure 3a shows the $\sigma(\lambda_e)$ parameter against λ_c at the various content of olivine in the mixtures from the olivine-free HED samples to the pure olivines of various composition. To discriminate between the mixtures of various olivine content we use so-called counter ellipses; each of them, proceeding from the existing dataset, bounds the probable range of data scattering at the given confidence probability, p. All ellipses in Fig. 3 correspond to p = 0.9. In this plot, the variation interval for the 950-nm band position over Vesta surface as specified in [8] is also shown.



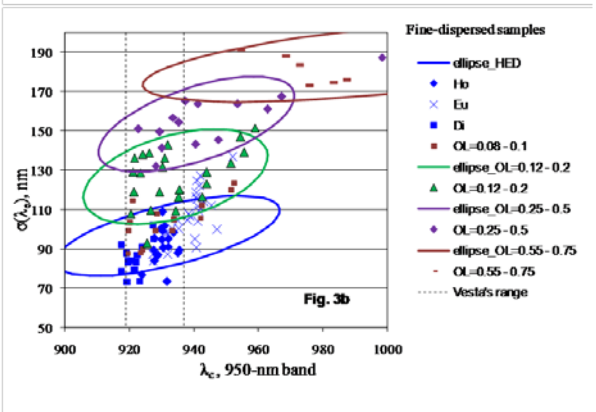
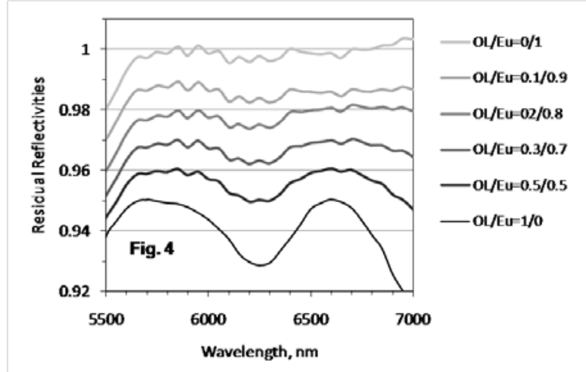


Figure 3b demonstrates the above plot on a larger scale. As is well seen from this Figure, not all HEDs in their spectra have the 950-nm band position similar to that in the spectra of Vesta's areas. The data permit the olivine-bearing areas (Ol > 50%) to be present on Vesta, and, as was mentioned above, such regions have already been found on the asteroid. Besides, the areas with low olivine content (Ol ~12 – 20%) could also exist on Vesta surface. The value of $\sigma(\lambda_e)$ between 110 and 130 nm in their reflectance spectra will clearly characterize such an opportunity. It is quite likely that such areas on Vesta may be discovered in the future.

A faint absorption band near 620 nm in reflectance spectra is another spectral marker of an olivine admixture. This spin-forbidden band of Fe^{2+} arises only in the spectra of olivines and becomes apparent in the spectra of olivine-HED mixtures even at low olivine



concentration (see Fig.4 and [5, 9] in more detail). If the band appears in the spectra we can be sure that we have dealing with just olivine rather than glasses or, say, clinopyroxenes.

Conclusions: We believe that the method proposed above will be useful for searching for olivines at its low concentration on the surface of Vesta and other V-type asteroids. At least for Vesta's surface in the range of λ_c variations (see Fig. 3b), we have the following sequence:

$\sigma(\lambda_e)$, nm	Olivine content, %
70 – 110	HED mineralogy, Ol<10
110 – 130	12 – 20
130 – 170	20 – 50
> 170	> 50

If olivine has been detected then the next step is the modeling of the spectrum under study in order to estimate the olivine content with more accuracy.

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Acknowledgments: The spectra of minerals and HED meteorites were taken from HOSERLab, RELAB, and USGS databases.