INVESTIGATIONS OF SOME CHONDRITES AND TERRESTRIAL BASALTS: VISUAL SPECTRA

Murtazov A.K., Efimov A.V., Zhabin V.S.

Ryazan State University named after S. Yesenin, Ryazan, Russia, akmurtazov@gmail.com

Introduction

The task of measuring terrestrial rock reflectance spectra and their comparison with the spectra of meteoroids and asteroids is extremely important. It is related both to the Solar system body origin and the problem of its evolution, as well as the problem of detecting space bodies threatening the Earth.

Researchers from many countries have accumulated extensive experimental and observational material on the comparison between spectral and photometric peculiarities of basic terrestrial rocks, stony asteroids, and meteorites [Chapman et al., 1975; Cloutis et al., 1994, 2011; Hiroi et al., 1993; Johnson, Fanale, 1973; Trigo-Rodriguez et al., 2013; Vernazza et al., 2008].

The paper presents the results of measuring the reflectance spectra from the lava samples collected in the caldera of Teide, Tenerife, and the reflectance spectra from a number of terrestrial basalt samples along with two samples of ordinary chondrites that hit the Earth' surface [Efimov, Kartashova, Murtazov, 2019; Murtazov, Efimov, 2017; Murtazov, 2018].

Measurements

We took measurements of the reflectance spectra based on the methods previously used for the experiments on physical simulation of photometric and spectral characteristics of satellite and asteroid surfaces [Murtazov, 2016]. We used a small-size monochromator with a 3–4 nm/mm dispersion concave diffraction grating. As a

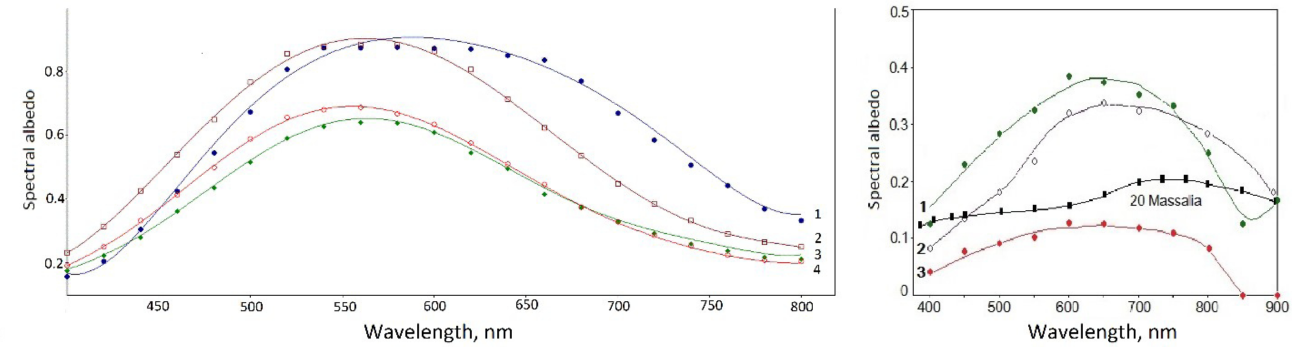

Fig. 1. Visual spectra of terrestrial basalts (left) and volcanic lava [Murtazov, Efimov, 2017; Murtazov, 2018]

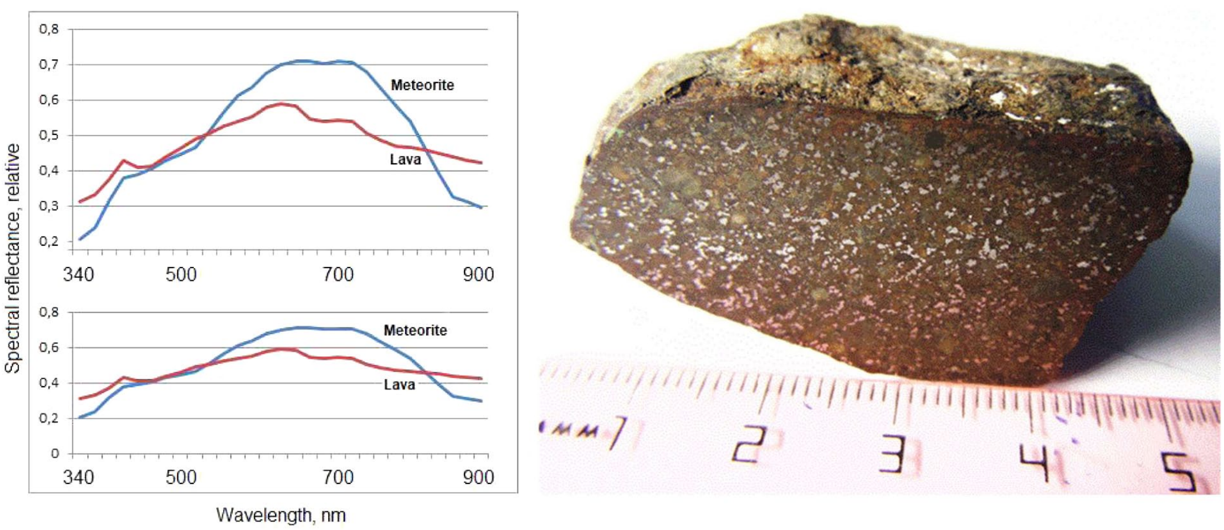

Fig. 2. Visual spectrum of the Sierra Gorda 008 ordinary chondrite [Efimov, Murtazov, Zhabin, 2021]

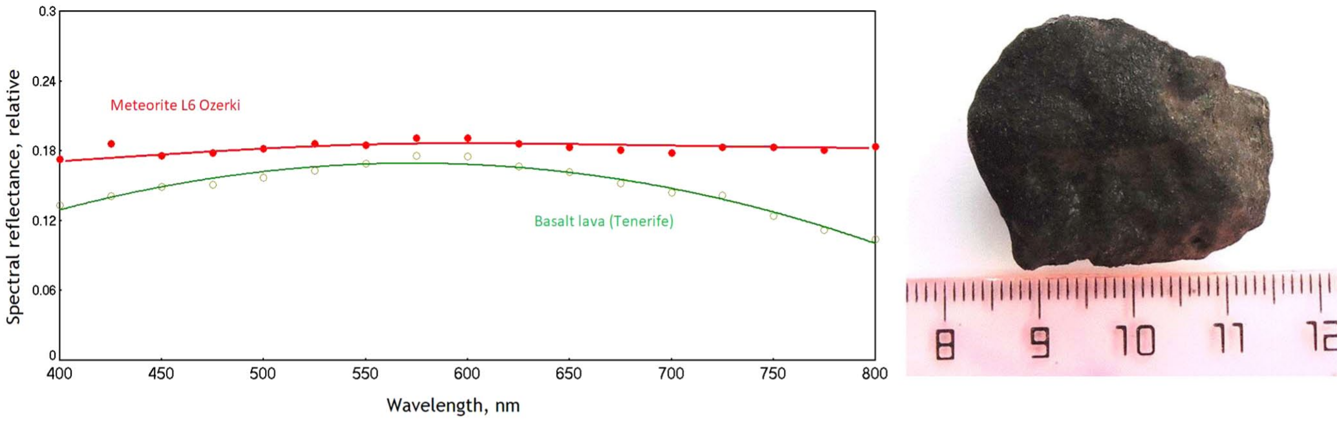

Fig. 3. Visual spectrum of the Ozerki ordinary chondrite [Efimov, Kartashova, Murtazov, 2019]

receiving instrument, we used a photoconductor, which was sensitive within the range of 400–900 nm. The incident and scattering light beams formed the angles of 0 and 45 degrees, respectively, to the sample surface normal. The flat surface of MgO was used as a reference. The relative error of the measurements was 3–4% in the middle of the spectral range and grew up to 10–12% at the range's limits.

Results

Figure 1, left, shows Earth basalt pictures and spectra from different regions of Russia, Ukraine, and Armenia, the chemical composition and exterior are quite similar to those of lava [Murtazov, Efimov, 2017; Murtazov, 2018]. With these, the radiation excess falls within 550–600 nm.

Figure 1, right, shows the spectra of lava from the Teide caldera, Tenerife [Murtazov, Efimov, 2017; Murtazov, 2018]. This lava belongs to acid basalt lavas and is colored from very dark brown or nearly black to light grey. It is typical of such volcanos and contains a number of chemical elements, e.g. sulfur. Their surface is covered with craters from volcanic gas bubbles, 0.5–1.0 mm in size, which perfectly well imitates the crater faced surface of the Solar system atmosphereless bodies. The lava sample spectral curves have a radiation excess of 600–750 nm and an absorption band of $\lambda > 800$ nm.

The meteorite of Sierra Gorda 008 was found in the Chile Atacama Desert, Antofagasta province by Timur Kryachko on April 10, 2018. Its coordinates are: Latitude 22°30.15'S; Longitude 69°7.97'W. It was classified as an ordinary chondrite H5.

We investigated the spectrum of the piece from this 53 g meteorite piece from the Museum of the Universe, Dedovsk, Moscow region (Fig. 2) [Efimov, Murtazov, Zhabin, 2021].

The Ozerki meteorite fell in June 21, 2018 near the city of Lipetsk, Russia. It was classified as an ordinary chondrite L6S4-5W0. The meteorite is covered with the

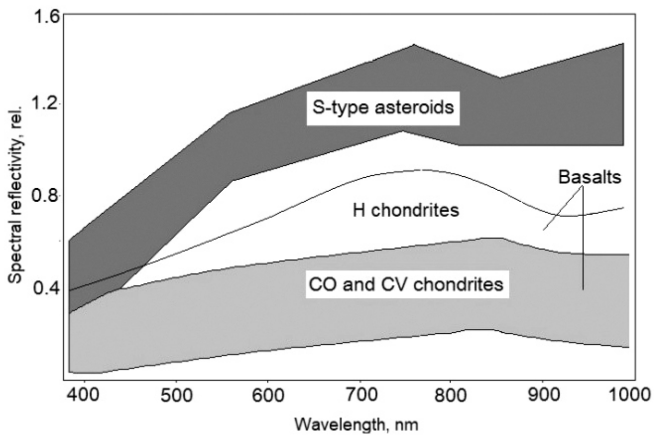

Fig. 4. Spectral reflectivity of stony asteroids, meteorites and basalts

crust resulting from its burnout while passing through the atmosphere. The inside part with the basic substance looks typical of chondrites [Sharygin, 2018]. The spectrum of this meteorite is normal for ordinary chondrites (Fig. 3) [Efimov, Kartashova, Murtazov, 2019].

Conclusions

The simplest comparative analysis of volcanic lava and basalt spectra with the spectra of stony meteorites (chondrites) shows that visibly they are rather similar.

Besides, these spectra are very much similar to those of the stony asteroids [Cloutis et al., 2011; Johnson, Fanale, 1973].

We also analyzed the data of the S-asteroid spectra acquired from observations, as well as the experimental data on stony meteorites [Chapman et al., 1975; Cloutis et al., 1994, 2011; Hiroi et al., 1993; Trigo-Rodriguez et al., 2013; Vernazza et al., 2008]. The analysis resulted in marking the areas on the "wavelength-albedo" plane, which occupy these surfaces (Fig. 4).

The results obtained are close to the multiple data presented by other researchers.

REFERENCES

1. Chapman D., Morrison B., Zellner B. Surface properties of asteroids: A synthesis of polarimetry, radiometry, and spectrophotometry // Icarus. 1975. V. 25. P. 104–130.
2. Cloutis E.A., Gaffey M.J., Moslow T.F. Spectral reflectance properties of Carbon-Bearing materials // Icarus. 1994. V. 107. P. 276–287.
3. Cloutis E.A. et al. Spectral reflectance properties of carbonaceous chondrites: 1. CI chondrites // Icarus. 2011. V. 212. P. 180–209.
4. Efimov A.V., Kartashova A.P., Murtazov A.K. Visual spectrum of chondrite L6 Ozerki // Meteoritics & Planetary Science. 2019. V. 54. S2. P. A100.
5. Efimov A.V., Murtazov A.K., Zhabin V.S. Visual spectrum of ordinary chondrite H5 Sierra Gorda 008: 84th Annual Meeting of the Meteoritical Society. Chicago, Illinois – August 14–21, 2021. Abstract 6002.
6. Hiroi T. et al. Modeling of S-type asteroid spectra using primitive achondrites and iron meteorites // Icarus. 1993. V. 102. P. 107–116.
7. Johnson T.V., Fanale F.P. Optical properties of carbonaceous chondrites and their relationship to asteroids // Journal of Geophysical research. 1973. V. 78. P. 8507–8518.
8. Murtazov A.K. Physical simulation of asteroid and artificial Earth satellite surface optical properties // Astronomical&Astrophysical Transactions. 2016. V. 29. P. 519–528.
9. Murtazov A.K., Efimov A.V. Comparison of the basalt spectra with the spectra of stony asteroids and meteorites // Ecological Bulletin of Research Centers of the Black Sea Economic Cooperation. 2017. No. 4. P. 117–123.
10. Murtazov A. Measuring of Some Basalts Spectra with the Comparison of the Metal Meteorite Spectrum // Meteoritics&Planetary Science. 2018. V. 53. P. A 218.
11. Murtazov A.K., Efimov A.V. Visual Spectra of Some Chondrites and Terrestrial Basalts: The 52nd Lunar and Planetary Science Conference (LPSC), NASA, Houston, March 15–19, 2021. Abstract 1172.
12. Sharygin V.V. Ni-rich metal-sulfide globules in fusion crust of L6 chondrite Ozerki, Lipetskaya oblast: preliminary data. In: 18th Russian conference on fluid inclusions at Moscow. 2018, September.
13. Trigo-Rodriguez J.M. et al. UV to far-IR reflectance spectra of carbonaceous chondrites. I. Implications for remote characterization of dark primitive asteroids targeted by sample-return missions // MNRAS. 2013. V. 437. P. 227–240.
14. Vernazza P. et al. Compositional differences between meteorites and near-Earth asteroids // Nature. 2008. V. 454. P. 858–860.