EPSC Abstracts
Vol. 13, EPSC-DPS2019-709-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

OH/H_2O characterization of near-Earth asteroids using 3-µm spectroscopy

Lauren E. McGraw (1, 2), Joshua P. Emery (1, 2), Cristina A. Thomas (2), Andrew S. Rivkin (3) and Nathanael R. Wigton (4)
(1) University of Tennessee, Tennessee, USA (lmcgraw@vols.utk.edu), (2) Northern Arizona University, Arizona, USA, (3) Johns Hopkins University Applied Physics Laboratory, Maryland, USA, (4) Oak Ridge National Laboratory, Tennessee, USA

1. Introduction

Near-Earth Asteroids (NEAs) are excellent laboratories for processes that affect the surfaces of airless bodies. Most NEAs were not expected to contain OH/H_2O on their surfaces because they formed in the anhydrous regions of the Solar System [1] and their surface temperatures are high enough to evaporate such volatiles. However, OH/H_2O has been discovered on other seemingly dry bodies in the inner Solar System, such as the Moon [2,5,8,9] and Vesta [3], with recent discoveries of OH/H_2O on the two largest NEAs [7]. Possible sources for OH/H_2O on these bodies include impacts of carbonaceous material [6] and solar wind proton implantation [4], though the factors that control the latter mechanism are unclear. The survey conducted by this study will enable determinations of OH/H_2O delivery and retention controlling factors, allowing for a better understanding of the volatile content of near-Earth space.

2. Methods

We observed NEAs using SpeX on NASA's Infrared Telescope Facility (IRTF) on Mauna Kea, Hawaii. Spectra were collected using both prism (0.7 – 2.52 µm) and LXD_short (1.67 – 4.2 µm) modes to accurately characterize asteroid type and the 3-µm region, where the OH/H_2O signature is present.

3. Results

We have made 34 observations of 23 NEAs as part of this ongoing project. Of those, 3 exhibit a definite absorption feature in the 3-µm region: (433) Eros, (1036) Ganymed, and (3122) Florence (Table 1). All three have been observed multiple times and by multiple observers [7]. Additionally, 3 more NEAs exhibit a potential 3-µm feature: 2014 JO25, (1627) Ivar (Figure 1), and (25916) 2001 CP44 (Table 1). The other 17 NEAs studied do not exhibit a measurable 3-µm absorption feature.

The three NEAs with a well-defined 3-µm feature share many characteristics. They all have diameters greater than 4.9 km, perihelia greater than 1 AU, and are S-type asteroids. Ivar and 2001 CP44 also exhibit all three similarities, though 2001 CP44 is an Sq-type asteroid. 2014 JO25 does not match any of the above trends (Table 1); its spectrum is also considerably noisier than the other NEAs that show potential features. Additionally, several other NEAs studied that do not exhibit a 3-µm feature share at least one of the potential controlling factors, implying that size, surface temperature (of which perihelion is a proxy), or composition alone are not enough to control OH/H_2O delivery and/or retention. Future studies will constrain the characteristics necessary for an object to exhibit a 3-µm absorption feature, enabling the prediction of which NEAs contain surface OH/H_2O.

Table 1: NEAs with 3-µm features

Object	D (km)	Tax.	q (AU)
1036 Ganymed	37.7	S	1.24
433 Eros	16.8	S	1.13
3122 Florence	4.9	S	1.02
1627 Ivar	9.2	S	1.12
2001 CP44	5.7	Sq	1.29
2014 JO25	0.7	Q	0.24

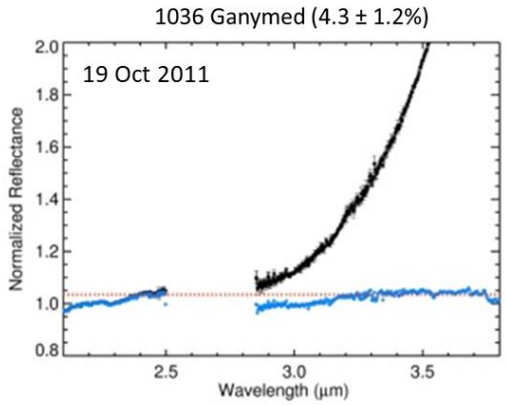

Figure 1: Spectrum of 1036 Ganymed as observed on 19 October 2011. The black data points are the original spectrum, the blue represent the thermally corrected spectrum, and the red is the thermal continuum.

Acknowledgements

This research is supported by the NASA SSO program, grant number NNX16AE91G.

References

[1] Binzel, R. et al.: The Near-Earth Object Population: Connections to Comets, Main-Belt Asteroids, and Meteorites, Asteroids IV, pp. 243-256, 2015.

[2] Clark, R.: Detection of Adsorbed Water and Hydroxyl on the Moon, Science, Vol. 326, pp. 562-564, 2009.

[3] De Sanctis, M. et al.: Vesta's mineralogical composition as revealed by the visible and infrared spectrometer on Dawn, Meteoritics & Planetary Science, Vol. 48, pp. 2166-2185, 2013.

[4] McCord, T. et al.: Sources and physical processes responsible for OH/H_2O in the lunar soil as revealed by the Moon Mineralogy Mapper (M^3), Journal of Geophysical Research, Vol. 116, E00G05, 2011.

[5] Pieters, C. et al..: Character and Spatial Distribution of OH/H_2O on the Surface of the Moon Seen by M^3 on Chandrayaan-1, Science, Vol. 326, pp. 568-572, 2009.

[6] Reddy, V. et al.: Delivery of dark material to Vesta via carbonaceous chondritic impacts, Icarus, Vol. 221, pp. 544-559, 2012.

[7] Rivkin, A. et al.: Evidence for OH or H_2O on the surface of 433 Eros and 1036 Ganymed, Icarus, Vol. 304, pp. 74-82, 2018.

[8] Sunshine, J. et al.: Temporal and Spatial Variability of Lunar Hydration as Observed by the Deep Impact Spacecraft, Science, Vol. 326, pp. 565-568, 2009.

[9] Wöhler, C. et al.: Time-of-day-dependent global distribution of lunar surficial water/hydroxyl, Science Advances, Vol. 3, 9 e1701286, 2017.