STRUCTURE AND COMPOSITION OF GEMINID METEOROIDS AND IMPLICATIONS FOR THE NATURE OF PHAETHON. J. Borovička, D. Čapek, P. Koten, P. Spurný, L. Shrbený and R. Štork. Astronomical Institute of the Academy of Sciences, CZ-25165 Ondřejov, Czech Republic. E-mail: borovic@asu.cas.cz.

Introduction: The Geminid meteor shower is one of the most intense annual meteor showers. The parent body of the shower is asteroid (3200) Phaethon. The orbit of the shower and its parent body is notable by the short period (~1.6 yr) and small perihelion distance (0.14 AU). Since the Phaethon discovery in 1983, the question has arisen, whether it is a regular asteroid or dormant comet. Phaethon and Geminids may be part of a broader complex of interplanetary bodies, which includes also asteroid 2005 UD and Daytime Sextantid meteor shower [1], suggesting the origin in hierarchical fragmentation of a comet. Detailed observations of Phaethon and 2005 UD have shown, however, no sign of cometary activity [2, 3, 4]. Licandro et al. [5] assigned Phaethon, on the basis of reflectance spectroscopy, to the group of activated asteroids originating in the outer main belt. The age of the Geminid meteoroid stream was estimated to 2000 years [6]. Geminids produce no meteorites because of their large entry speed (36 km/s), nevertheless, their strength and density was found by several authors to be closer to stony meteorites than to cometary meteoroids [7]. This fact could be however, attributed to the loss of volatiles due to solar heating near perihelion [8].

In this paper we use complex observational data of Geminid meteors and theoretical modeling of loss of volatile sodium in interplanetary space to infer the physical properties and composition of Geminid meteoroids. The ultimate goal is to constrain the properties and origin of Phaethon.

Methods: We used data of Geminid meteors of brightness from magnitude +3 to –8, observed mostly in 2004 and 2006. Faint meteors were observed by image intensified video cameras. Photographic data were used for bright meteors. Both techniques included meteor spectroscopy. Lines of Mg, Na, and Fe were used to derive abundances of these elements. Double station data were used to derive meteor heights, velocities, decelerations, and light curves. The erosion model for dustball meteoroids, recently developed for the analysis of Draconid meteors [9], was applied to those faint Geminids, with showed measurable decelerations.

A model of the loss of sodium from meteoroids orbiting the Sun by thermal desorption was developed. The most appropriate diffusion coefficients were taken from geological literature. The percentage of lost sodium from meteoroids on Geminid orbit was computed as a function of time and particle size.

Results: The spectroscopic analysis showed that the Mg/Fe ratio is 1.5–3 times larger in Geminids than the chondritic value. Similar values were earlier found for cometary showers Leonids and Perseids [10], which suggests cometary origin of Geminids. The Na abundance in Geminids is generally low but shows large variations from meteor to meteor. The Na/Mg ratio is always lower than chondritic. There is a weak trend of increasing Na abundance with increasing meteoroid mass; nevertheless, the spread of values is large for each mass interval within the range of 10^{-6} to 3×10^{-4} kg. Theoretical computation showed that substantial part of sodium can be lost by thermal desorption within 2000 years only from meteoroids smaller than about 100 microns or from porous meteoroids consisting of grains smaller than 100 microns. Preliminary analysis of meteor decelerations indicates that Geminids may really be composed of constituent grains. Final conclusions will be presented at the meeting.

References: [1] Ohtsuka K. et al. (2006) *Astron. Astrophys.* 450, L25–L28 [2] Hsieh H.H. and Jewitt D. (2005) *Astrophys. J.* 624, 1093–1096. [3] Jewitt D. and Hsieh H.H. (2005) *Astron. J.* 132, 1624–1629. [4] Wiegert P.A. et al. (2008) *Icarus* 194, 843–846 [5] Licandro et al. (2007) *Astron. Astrophys.* 461, 751–757 [6] Ryabova G. O. (2007) *Mon. Not. R. Astron. Soc.* 375, 1371–1380 [7] Borovička J. (2006) *Proceedings IAU Symposium No. 229*, 249–271. [8] Borovička J. et al. (2005) *Icarus* 174, 15–30. [9] Borovička J. et al. (2007) *Astron. Astrophys.* 473, 661–672 [10] Borovička J. (2005) *Earth, Moon, and Planets* 95, 245–253.