SOME OBSERVATIONAL INDICATIONS OF THE HISTORY AND SRUCTURE OF OUR PLANETARY SYSTEM. V.V. Busarev, Sternberg State Astronomical Institute, Moscow University, Moscow, Russian Federation; e-mail: busarev@sai.msu.ru.

Introduction: E-, M- and S-type asteroids are widely considered as remnants of differentiated parent bodies; specifically, Ms might have been their cores [e. g., 1, 2]. The conviction is based on the visible-range albedo (medium to high) and overall spectral curves (slightly reddish to red) of the small planets corresponding to these of metal iron and igneous silicate assemblages. But observational data suggesting the presence of highly oxidized or even hydrated silicates on the surfaces of the bodies were recently obtained [3-13]. In particular, it was shown that 10 M-type asteroids (or about 24% of the known main-belt M- asteroids) and three E-type asteroids have absorption bands at 3 μm diagnostic of water of hydration [9-11]. At the same time weak absorption features characterizing presence of highly oxidized and/or hydrated silicates were discovered on 5 M- and 3 S- asteroids (at 0.43 and 0.6-0.8 μm) [3-8] and on 3 E-asteroids (at 0.5 μm) [12, 13]. Because of probable unusual combination of very different materials on the E-, M-, and S-type small planets the data should be correctly explained. It follows probably from the history of the Solar System.

Discussion: Rivkin et al. [9-11] have proposed that hydrated M-class (21, 22, 55, 77, 92, 110, 129, 135, 136, 201) and E-class (44, 64, 214) asteroids identified by an absorption band at 3 μm in their reflectance spectra are not *primarily* of igneous origin and should be placed in the separate W (wet)- class. In their opinion the bodies were mistakenly ascribed before to the spectral classes of igneous objects. It was probably because of spectral similarity of bright hydrated salts (e. g., sulfates and carbonates that may present on the surfaces of the bodies together with phyllosilicates) to reflectance characteristics of Fe-Ni metal and igneous minerals (enstatite, feldspar, pyroxene, etc.). We may not exclude such a possibility for a few asteroids of the classes, but it is not possibly true for the all M-asteroids found to be hydrated.

From the obtained reflectance spectra of the M- and S- asteroids having weak absorption features [4-8] it follows that the regolith of the bodies may consist of not only Fe-Ni metal and igneous silicates but also of highly oxidized (including ferric oxides) and hydrated minerals. We consider the spectral features at 0.43 μm and 0.6-0.8 μm as integrated signs of presence of oxidized and/or hydrated (o/h) silicates in the matter of the M- and S- asteroids. It seems the spectral features superimpose to the spectral characteristics of metal iron and igneous silicates.

So far the most number of hydrated asteroids from igneous classes belongs to the M-class, then they should be firstly investigated. In attempt to understand a real nature of the asteroids we have compared them with other bodies of the M-class in heliocentric position (semi-major axes of orbits). It was taken a useful picture of distribution of the asteroid taxonomic classes in heliocentric distance [2] according to Tholen classification [14] (Fig. 1). The average heliocentric positions of hydrated M-type asteroids (hMs) and o/hMs (hMs plus 75 and 161 asteroids having possible spectral traces of oxidized and/or hydrated silicates [4, 8]) were marked. It is seen that both mean distances (ab. 2.67 and 2.70 A. U.) are noticeably less than that of the whole M-class (ab. 2.87 A. U.). It may be considered as a strong indication of the same origin of hMs (or o/hMs) and Ms.

If water ice and hydrated silicates could not originate together with Fe-Ni-metal and high-temperature silicates (at 1000-2000°C), how and when could they get to the igneous bodies? It may be answered if we take into account possible evolution of the asteroid belt and the neighbouring giant planets, Jupiter in the first place. A cosmogonic model developed by Safronov and his collaborators [e. g., 15-17] gives us a very probable scenario of this. As it was for the first time shown [16], most of the asteroid bodies were swept out from the asteroid belt by planetessimals from Jupiter's zone of accumulation in the time of its runaway formation. Due to gravitational interaction with Jupiter's core the remaining large icy bodies were gaining chaotic velocities up to 3 km/s and more and piercing the asteroid belt [17]. As a result of the process it might have been delivering to the whole asteroid zone and the asteroid parent bodies a considerable icy (or silicate-icy) component.

It is probably corroborated by presence of highly oxidized and/or hydrated silicates on the asteroids of the three main igneous classes. Once more reason of the past collisions of igneous asteroids with hydrated primitive ones may be uneven distribution of oxidized and/or hydrated silicates on the surfaces of almost all observed asteroids [4-8].

Conclusions: Thus, there are three main arguments for delivering water ice and/or phyllosilicates to the asteroids of igneous origin mostly from Jupiter's zone of formation:

- there are definite observational facts of presence of oxidized and/or hydrated silicates on the surfaces of asteroids of three igneous classes (M, E and S);
- the average heliocentric distance of the hydrated M-type asteroids is less than that of the M-type asteroids in the whole that points out to their common origin;
- there is a noticeable uneven distribution of oxidized and/or hydrated silicates on the surfaces of observed igneous asteroids as probable indication of their previous collisions with primitive bodies.

It all may be considered as a direct confirmation of cosmogonic models [e. g., 15-18] in which Jupiter's formation (and its duration) and position in the Solar System played a key role in the evolution of the asteroid belt. Therefore, the models and mentioned observational data suggest:

- Jupiter's runaway formation probably begun in the time or after the process of the asteroid parent bodies' differentiation;
- the undisturbed structure of the asteroid belt – the distinct gradual changing of the main asteroid types with heliocentric distance from igneous to primitive ones [19] and possible signs of water ice delivering to igneous asteroids from outside indicate an external and close position of Jupiter relatively to the asteroid belt during their evolution; probably Jupiter's distance from the Sun couldn't considerably change for the history of the Solar System.

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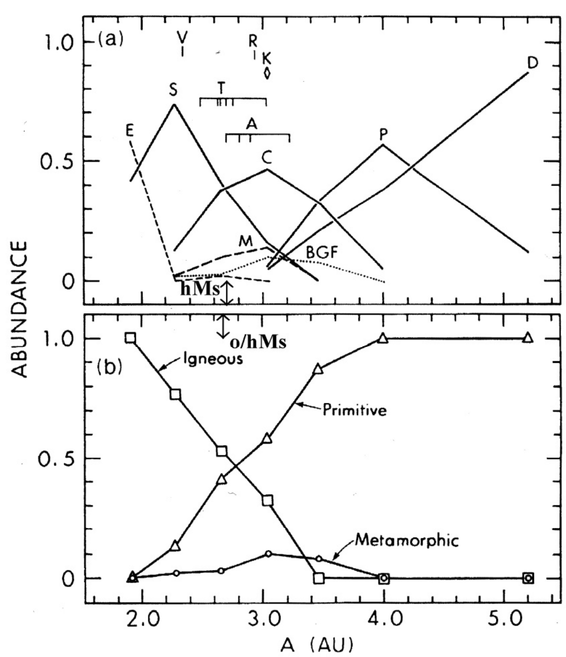

Fig. 1.