A possible link between asteroid (21) Lutetia and CH3 chondrites based on UV to NIR reflectance spectra

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We compare an ultraviolet to near-infrared (UV-NIR) spectrum of the CH3 carbonaceous chondrite Pecora Escarpment 91467 (PCA 91467) with two different reflectance spectra from the asteroid (21) Lutetia in order to investigate the possible relation between them. (21) Lutetia is a large main-belt asteroid usually showing flat and featureless spectra in the 0.15 to 2.5 μm range [1] but with some strong signatures depending on the region observed [2], which make its spectral classification quite difficult. Due to its moderately-high albedo and presumably high metal content it has been considered an M taxonomic type asteroid into the X-group according to the Tholen classification [3], but also as an uncommon Xk transition type asteroids into the X-group of the SMASS classification [4], or one of the very rare Xc transition type asteroids [5].

We propose that this asteroid could be the parent body of the CH group of carbonaceous chondrites, as they are meteorites with a moderately to high metal content, which also provides a high reflectivity level [6] consistent with the albedo of (21) Lutetia. Besides, the flat spectra obtained from this asteroid are consistent with the usually flat and featureless spectra of most carbonaceous chondrites (CCs). We obtained the meteorite spectrum using a Shimadzu UV3600 UV-Vis-NIR spectrometer in order to obtain the characteristic reflectance spectra of these meteorites. The standard stage for the spectrometer is an integrating sphere with a working range from 200 to 2,000 nm. We compared the reflectance spectra from the northern region of the asteroid (21) Lutetia and the CH3 meteorite PCA 91467. The distinctive slope and features, together with the degree of absolute reflectance, allow us to establish possible relationships between these two objects. The asteroid taxonomy seems to point to a connection too, as both objects can be related to the asteroids belonging to the X-complex, some of whose members are sometimes related with metal-rich objects like the CHs. In fact, CH chondrites exhibit reflectance and mineralogical properties that suggest that their parent bodies can be found among moderate albedo asteroids with featureless spectra, and the peculiar combination of a high content in carbon and metal common in CH chondrites can explain many of the special properties of (21) Lutetia, or at least of the specific region studied [2].

It is remarkable that the UV-NIR spectra of CH, CR and CB chondrite groups are more reflective than those of other primitive CCs [6]. We know that these three groups are particularly rich in metal grains and the richer they are in metal the higher the degree of reflectance. In the case of CHs this seems to be consistent with (21) Lutetia's overall reflectance behavior. We found that the two spectra are reasonably similar taking into account the differences between our PCA 91467 polished section and the regolith-covered surface expected for (21) Lutetia. It is obvious that the asteroid spectrum should exhibit some differences as its surface is probably affected by space weathering. In fact, space processing particularly produces reddening and higher reactance in the NIR region where both spectra differ more. Moreover, supporting our previously cited conclusions, the inferred density of this asteroid is very close to the bulk density calculated for CH meteorites of $\sim$ 3,650 kg/m^3 [7]. Obviously, a careful deciphering of the absorption bands and other features is still needed to establish a relationship, but the possibility of an association among (21) Lutetia and the CH group of chondrites, even suggesting that Lutetia is their parent body, should be considered.

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References: [1] Sierks, H. et al. 2011, Science, 334, 6055, 487–490. [2] Barucci, M. A. et al. 2012, PSS, 66, 1, 23–30. [3] Tholen, D. J. 1989, in Asteroids II, ed. R. P. Binzel, T. Gehrels, & M. S. Matthews (University of Arizona Press, Tucson) 1139. [4] Bus, S. J. & Binzel., R.P. 2002, Icarus, 158, 146. [5] DeMeo, F. E., Binzel, R. P., Slivan, S. M., & Bus, S. J. 2009, Icarus, 202, 160. [6] Trigo-Rodríguez, J. M. et al. 2014, MNRAS, 437, 227. [7] Macke, R. J., Britt, D. T., Consolmagno, G. J., & Hutson, M. L. 2010, Meteorit. Planet. Sci., 45, 1513–1526.