SANTORINI, ANOTHER METEORITE ON MARS AND THIRD OF A KIND. C. Schröder[1], J. W. Ashley[2], M. G. Chapman[3], B. A. Cohen[4], W.H. Farrand[5], I. Fleischer[1], R. Gellert[6], K. E. Herkenhoff[3], J. R Johnson[3], B. L. Jolliff[7], J. Joseph[8], G. Klingelhöfer[1], R. V. Morris[9], S. W. Squyres[8], S. P. Wright[10], and the Athena Science Team, [1]Institut für Anorganische Chemie und Analytische Chemie, Johannes Gutenberg-Universität, Staudinger Weg 9, D-55099 Mainz, Germany, schroedc@uni-mainz.de, [2]Mars Space Flight facility, School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287, [3]U.S. Geological Survey, Flagstaff, AZ 86001, [4]NASA Marshall Space Flight Center, Huntsville, AL 35812, [5]Space Science Institute, Boulder, CO 80301, [6]Department of Physics, University of Guelph, Guelph, Ontario, Canada, [7]Department of Earth and Planetary Sciences and the McDonnell Center for the Space Sciences, Washington University, St. Louis, MO 63130, [8]Department of Astronomy, Cornell University, Ithaca, NY 14853, [9]NASA Johnson Space Center, Houston, TX 77058, [10]Institute of Meteoritics, University of New Mexico, Albuquerque, NM 87131.

Introduction: The Mars Exploration Rover (MER) Opportunity has been studying Meridiani Planum for five years. On sol 1634 of its mission, Opportunity left Victoria crater after investigating it for approximately 682 sols [1] and is now on a journey towards Endeavour, a 24 km diameter crater about 12 km southeast of Victoria. A priority along the way is the investigation of cobbles, which in the jargon of the MER science team denotes any loose rock fragment larger than a couple of centimeters. Cobbles investigated thus far are of diverse origin [2] and provide the only means to investigate material other than the ubiquitous sulfate-rich outcrop, basaltic sand or hematite-rich spherules dubbed blueberries. Some of these cobbles are meteorites [3]. Meteorites on Mars are not just a curiosity that make Mars a more Earth-like planet. Metallic iron in meteorites, for example, may be used as a more sensitive tracer for volatile surface interactions compared to igneous minerals [4].

Between sols 1713 and 1749, including the period of Mars solar conjunction, Oportunity investigated a cobble informally named Santorini. Its chemical and mineralogical composition is very similar to Barberton and Santa Catarina, two cobbles that were identified as meteorites and which are probably related to each other [3]. Santorini was investigated with the rover's Panoramic Camera (Pancam), Microscopic Imager (MI), Alpha-Particle X-ray Spectrometer (APXS) and Mössbauer (MB) spectrometer. The miniature Thermal Emission Spectrometer (mini-TES) was not operational at the time. The Rock Abrasion Tool (RAT) could not be used to brush off potential dust coatings because of unfavorable geometry.

Pancam: Santorini and its angular features are shown in the Pancam image in Figure 1. The cobble measures approximately 6 by 8 cm. The top of the rock shows a relatively high reflectance, maybe as a result of wind-polishing. Pancam spectra show a broad downturn towards 1009 nm consistently across its surface. Santa Catarina is part of an extended cobble field which showed two different spectral types: One with a broad NIR absorption with an apparent band minimum at 1009 nm, and one with a narrower NIR absorption with a 934 nm band minimum and a distinct 864 to 904 nm downturn. Santa Catarina is of the second type [3]. The differences may be a consequence of sampling because only a few pixels per cobble were averaged. For example, the sampling might have preferentially hit olivine phenocrysts on some, e.g. Santorini, and low Ca pyroxene on others.

Figure 1. Pancam false color image of Santorini (Sol1713B_P2588_1_False_L257). The upper surface shows a relatively high reflectance.

MI: An anaglyph of Santorini obtained with the MI is shown in Figure 2. Part of the Santorini surface has a glassy, reflective luster and appears cleaner than other, dust-covered areas. Compared to Santa Catarina, which had several clasts clearly visible in MI images [3], Santorini does not look like a breccia. However, there appears to be at least one angular clast below center in the MI anaglyph.

APXS: Going by the example of Santa Catarina, which revealed a brecciated nature in MI images, two spots on Santorini were measured with the APXS to look for possible inhomogeneities. However, the two

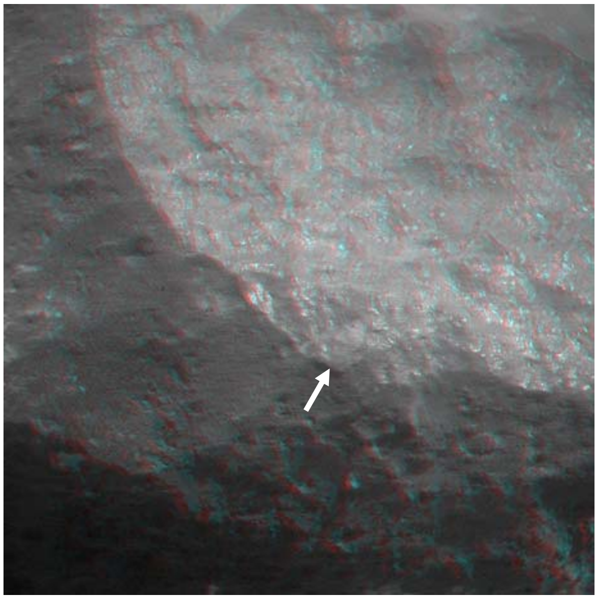

Figure 2. Microscopic Imager anaglyph of Santorini. Arrow indicates an angular clast.

spots have virtually the same elemental composition and are very similar to Santa Catarina and Barberton, which had an ultramafic composition with unusually high Ni [3].

MB: Preliminary analysis of the MB data reveals the Fe-bearing mineralogy of Santorini: The MB spectrum is dominated by the basaltic minerals olivine and pyroxene. The spectrum also shows a ferric oxide component, troilite and possibly minor kamacite and looks overall very similar to the MB spectra of Barberton and Santa Catarina (Figure 3). The range of Fe oxidation states suggests the presence of a fusion crust, fines welded onto Barberton upon impact, and/or a weathering rind. Weathering products may include Ni-rich Mg-sulfates and ''metallic rust'' rich in Fe, Ni, and S, such as identified as terrestrial weathering products in meteorites collected in Antarctica [3].

Implications for Mars: Kamacite and/or troilite were identified in Barberton, Santa Catarina and Santorini, suggesting a meteoritic origin. The three cobbles have a very similar chemical composition and appear to be most consistent with the mesosiderite meteorite class [3]. Because mesosiderites are a relatively rare class of meteorites, and because of their similarity in chemical and mineralogical composition we assume that Barberton, Santa Catarina and Santorini are all fragments of the same originally larger body. The distribution of these fragments is of importance: Barberton, with a length of ~3 cm the smallest fragment of the three, was encountered at the rim of Endurance crater, ~7 km to the north of Victoria crater; Santa Catarina and the surrounding cobble field is located at the Cabo Anonimo promontory on the northwestern part of the rim of Victoria; Santorini was discovered ~800 m south of Victoria. Seemingly surrounding Victoria, it is possible that Barberton, Santa Catarina and Santorini are part of the impactor that created the crater. They may be resistant-to-erosion remnants of the ejecta blanket, possibly impact breccias, and/or spalled-off fragments from the impactor. However, we have not sampled the distribution to the east and west of Victoria, and we have only investigated terrain to the south and west of Endurance and therefore do not know the complete extent of the distribution of these fragments. Their distribution may be the result of an air burst, and the extent of the distribution would have implications on the thickness of the atmosphere at that time, or they may have been part of a meteoroid stream. The investigation of cobbles along Opportunity's path towards Endeavour will continue and maybe add yet another fragment.

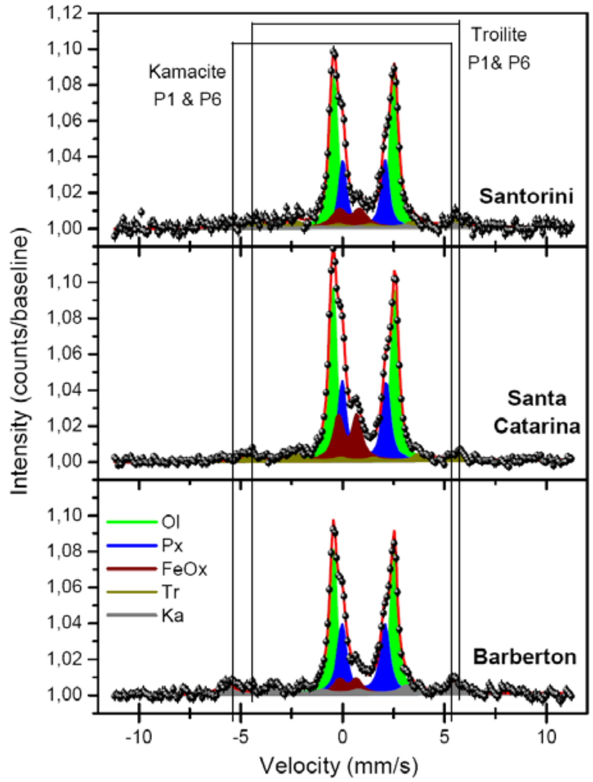

Figure 3. Comparative plot of Mössbauer spectra of the cobbles Barberton, Santa Catarina and Santorini. Positions of peaks 1 and 6 of characteristic sextets of kamacite and troilite, respectively, are indicated.

References: [1] Squyres et al., submitted to *Science*. [2] Jolliff B. L. et al. (2006) *LPS XXXVII*, 2401. [3] Schröder C. et al. (2008) *JGR, 113*, E06S22, doi:10.1029/2007JE002990. [4] Ashley J. W. et al. (2007) *LPS XXXVIII*, 2264.