IMAGING INCLUSION SPECTRAL DIVERSITY IN CARBONACEOUS CHONDRITES WITH MASCAM.
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Introduction: In October 2018, MASCOT successfully completed its 17-hour mission on the surface of Cg-type asteroid Ryugu. The bulk composition of Ryugu is thought to be best represented by thermally metamorphosed carbonaceous chondrites, mostly because of their low albedo over the visible wavelength range [1]. Close-up images of a small rock in front of the lander made by the MASCOT camera (MASCam) reveal small inclusions set in a dark matrix, confirming the link between C-type asteroids and carbonaceous chondrites [2]. However, MASCOT also found the rock to be highly porous [3]. Rocks such as these may not survive entry into the Earth atmosphere, and representative carbonaceous chondrites may not actually exist. We address the issue of representativeness by imaging several carbonaceous chondrites with a MASCam spare in an experiment performed at the Natural History Museum in Berlin, Germany, and compare the results with images from the surface of Ryugu.

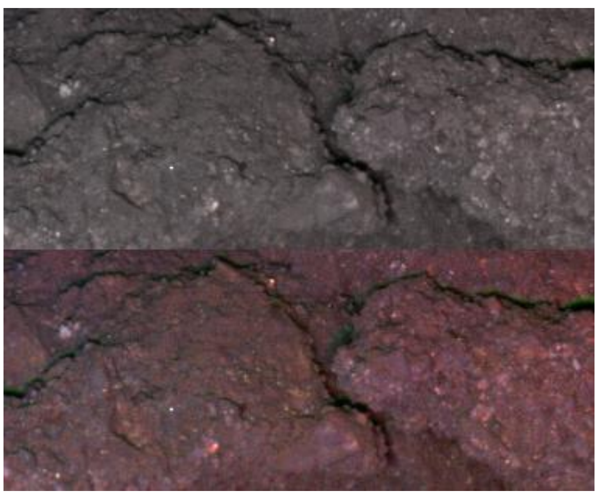

Figure 1. A color (RGB) composite of the Ryugu rock in front of MASCOT. The inclusions are shown at their full brightness range, in natural colors at the top and saturated colors at the bottom.

Ryugu images: Images of a Ryugu rock acquired by MASCam show abundant, predominantly bright, inclusions (Fig. 1). Most of these feature either a blue or red spectral slope in the visible wavelength range [2]. The colors of the inclusions are barely perceived in the natural color view (top), but after strongly saturating the image (in the HSL color space) they appear more distinctly blue and red (bottom). The smallest inclusions are sub-mm sized, whereas the largest are several millimeters large.

Meteorite imaging campaign: The meteorites that we imaged are listed in Table 1 and were selected from the collection of the Natural History Museum. We included mostly known meteorite falls to limit and better assess terrestrial contamination of the meteorite surface. The surface of the meteorites in our sample was often rough (fractured), and sometimes smooth (cut). We imaged the meteorites with the MASCam engineering model (EM), which is fully functional and partly calibrated, using LED illumination in four colors: blue, green, red, and IR (effective wavelengths: 471, 532, 633, and 809 nm [4]). As an example of the data that were collected, Figure 2 shows a color composite of one of the meteorites, displayed in similar fashion as the Ryugu rock in Fig. 1 (top). In this paper we analyze the spectral properties of the inclusions and compare their color variation and abundance with those in the Ryugu rock. A companion paper [5] will focus on analyzing the size distribution and morphology of the inclusions in the meteorites in Table 1.

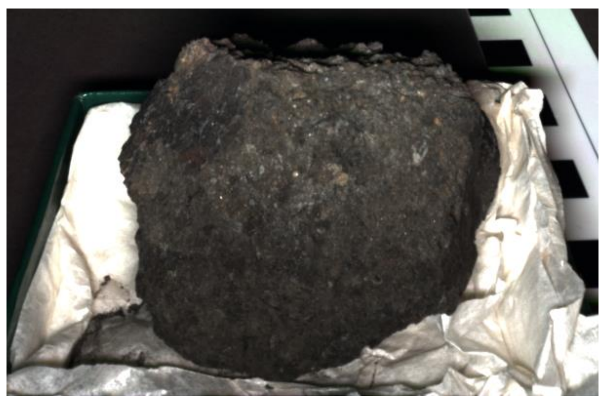

Figure 2. A natural color (RGB) composite of a piece of the Orgueil meteorite, as imaged in the experiment, displayed at the full brightness range of the inclusions.

Outlook: The experiment was performed in August 2019, and we are currently analyzing the data. By quantifying the spectral diversity of the inclusions, we will identify which of the carbonaceous chondrite in our sample matches the Ryugu rock best. We hope to present the first results at the workshop.

References: [1] Sugita S. *et al*. (2019) Science 364, eaaw0422. [2] Jaumann R. *et al*. (2019) Science 365, 817–820. [3] Grott M. *et al*. (2019) *Nature Astronomy*, doi:10.1038/s41550-019-0832-x. [4] Jaumann R. *et al*. (2017) *SSR*, doi: 10.1007/s11214-016-0263-2. [5] Otto, K. *et al*., this workshop.

Table 1. Carbonaceous chondrites selected for imaging.

Meteorite	**Sp. type**	**Type**	**Year**
Allende	CV3	Fall	1969
Colony	CO3.0	Find	1975
El-Quss Abu Said	CM2	Find	1999
Karoonda	CK4	Fall	1930
Lancé	CO3.5	Fall	1872
Mighei	CM2	Fall	1889
Murchison	CM2	Fall	1969
Murray	CM2	Fall	1950
Ningqiang	C3-ung	Fall	1983
Nogoya	CM2	Fall	1879
NWA 11118	CM2	Find	2016
Orgueil	CI1	Fall	1864
Ornans	CO3.4	Fall	1868
Warrenton	CO3.7	Fall	1877