Geological mapping of the Hokusai (H05) quadrangle of Mercury

Conference or Workshop Item

GEOLOGICAL MAPPING OF THE HOKUSAI (H05) QUADRANGLE OF MERCURY. D. A. Rothery[1], J. Wright[1], M. R. Balme[1] and S. J. Conway[2], [1]School of Physical Sciences, The Open University, Milton Keynes, MK7 6AA, UK (david.rothery@open.ac.uk), [2]LPG Nantes – UMR CNRS 6112, Université de Nantes, France.

Introduction: MESSENGER data are being used to construct ~1:3M scale quadrangle geological maps of Mercury [1,2,3,4, 5]. Here, we present our progress mapping the Hokusai (Fig. 1) quadrangle.

Data and Methods: Since Hokusai is a mid-northern latitude quadrangle (0-90° E; 22.5-66° N), its map is being produced in a Lambert Conformable Conic projection. Linework is being drawn at the 1:400k scale using ArcGIS for publication at the 1:3M scale, in accordance with USGS recommendations [6]. As a result, this map will be compatible for merging with the other new quadrangle maps of Mercury [7].

The primary basemap for mapping is constructed from the MESSENGER MDIS basemap tiles, with an average ground resolution of 166 mpp. Since this work began, additional MESSENGER products have been released that are being used to inform the mapping. These include global topography [8], global mosaics with high-incidence illumination from the east and west [9] and a global enhanced colour mosaic [10].

In order to determine a morphostratigraphy for the region, craters are classified by their degration state. Two classification systems are currently applied to Mercury: the five class system of the global geological map of Mercury [11] and the three class system used in the recently pubished quadrangle maps [1,2,3]. We are attempting to use both classification schemes simultaneously, classifying all craters >20 km in diameter. This will ensure the Hokusai map is compatible with the global map of Mercury and the other quadrangle maps.

Mapped Units and Features: We have concentrated on mapping the northern half of the quadrangle.

Smooth plains. The extensive smooth plains in the quadrangle are mostly part of the Northern Plains of Mercury [12]. These plains are characterised by their low crater density. They have the clearest contact relationships with other units and host younger craters, which are the simplest to classify. They contain abundant wrinkle ridges. Ghost craters are also widespread, which distinguishes the Northern Plains from the Caloris-related plains [13].

Intercrater plains. These are an older plains unit that is more heavily cratered than smooth plains, and is dominant in the south of the quadrangle. Intercrater plains host the older degradation classes of craters. Contacts between intercrater plains and other units, such as crater ejecta sheets, are much more uncertain than smooth plains contacts, hence this unit is being mapped after the smooth plains.

Impact crater units. The strategy for mapping impact craters depends on their diameter. Fresh crater rims 5-20 km in diameter are marked with a simple outline on the map. Heavily degraded small craters, characteristic of the intercrater plains [14], are not marked separately. As well as having their rim crests outlined, craters >20 km have their rim material and ejecta deposit mapped together as a unit. The crater interior is mapped as a separate unit. The conditions of the ejecta, rim and interior materials are used to assign a degradation class to these craters [11]. Currently, only the youngest craters in the quadrangle have been classified. These are C3 in the scheme of [7] and correspond to C1 and C2 craters on the global map [11] on which the age-numbering runs the other way (from oldest to youngest). Crater interior units are either smooth, hummocky or a mixture of both.

Wrinkle ridges. There are two distinct types of wrinkle ridges within Hokusai quadrangle: common wrinkle ridges and wrinkle ridge rings, which indicate impact crater buried by the smooth plains (ghost craters). We are mapping these two types of wrinkle ridge separately as the spatial and size distributions of ghost craters informs us about plains emplacement (number of flow events, their lengths and thicknesses) [12].

Unity Rupes. This is the largest lobate scarp (~350 km) within the Hokusai quadrangle [1]. It appears to be a right-lateral ramp at the northernmost extent of a ~2000 km long fault system that encompasses Blossom Rupes to the south. Massironi et al. used the M1M2M3M10 (MESSENGER flyby and Mariner 10) mosaic to study this system [15]. We will reanalyse this fault system using newer orbital MESSENGER data. We will attempt to characterise fault slip along strike using faulted craters [16]. Lobate scarps are relatively uncommon in this quadrangle, possibly due to the high proportion of smooth plains, which accommodate strain via wrinkle ridges rather than lobate scarps [17].

Volcanic features. The Hokusai quadrangle contains Mercury's largest putative pyroclastic deposit and vent, informally referred to as NE Rachmaninoff [18] as well as several smaller examples. Deposit extents are most easily seen using enhanced colour. These will have a semi-transparent symbology as underlying units are still readily discernible. Vent edges will be marked if they will be clear at the publication scale. Volcanic features that cannot be resolved at the publication scale will have their locations marked as points on the map.

Future Work: Once the smooth plains (and superposing features) within the Hokusai quadrangle have been fully mapped, we will begin mapping the older plains units and their craters.

Classification of craters >20 km in diameter by their degradation state will continue using the two schemes in parallel. This will be done to test whether the five class scheme can be applied at the quadrangle scale without crater morphology apparently contradicting superposition relationships [19].

Some quadrangle maps produced using Mariner 10 data included a third plains unit intermediate in texture between smooth plains and intercrater plains [e.g. 20]. The global geological map being produced by Prockter et al. currently ony contains smooth plains and intercrater plains [21]. Quadrangle mappers using MESSENGER data have mapped regional units that are perhaps less significant at the global scale, including plains resembling Mariner 10 intermediate plains [1]. When we map the south of Hokusai, we will decide whether the plains units there can be subdivided into different recognizable units with sensible stratigraphic relationships and provenances.

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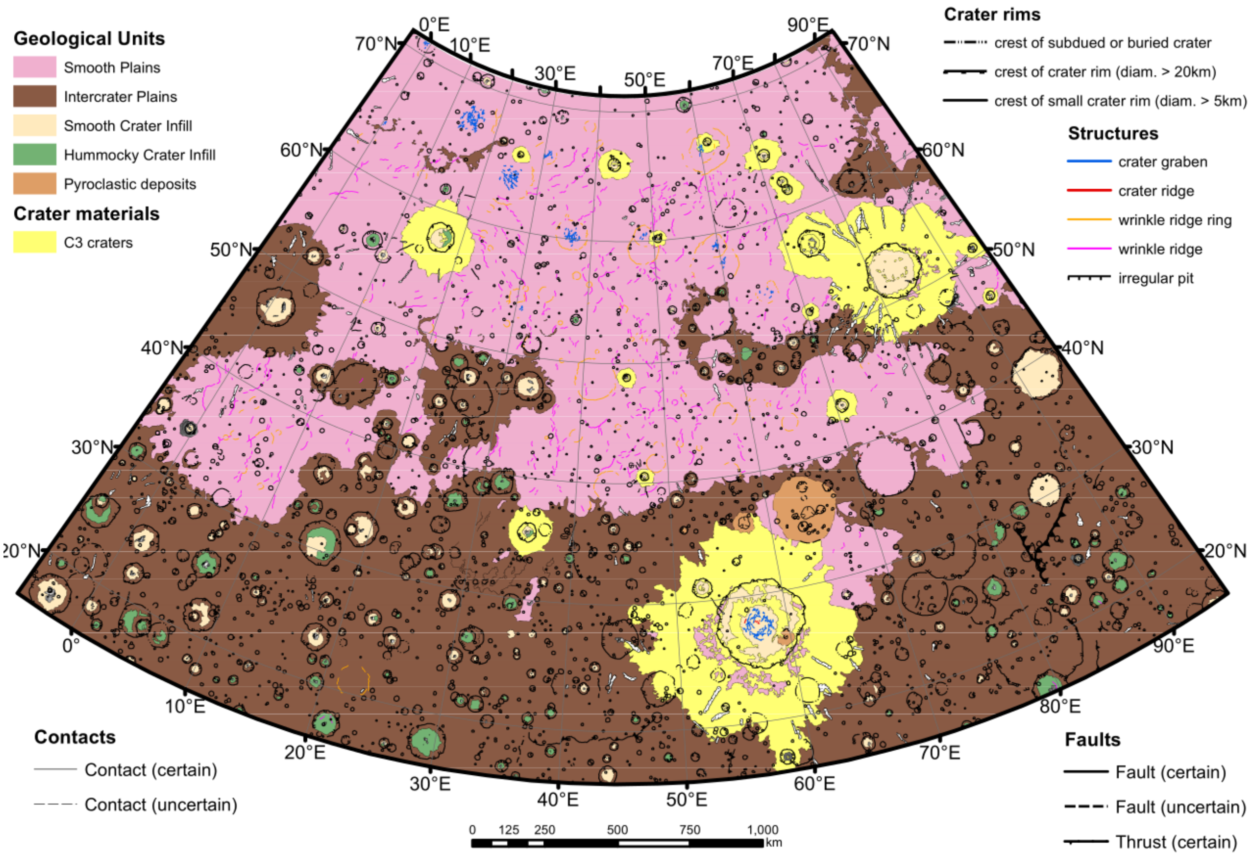

Fig. 1. *Our current working geological map of the Hokusai quadrangle of Mercury. 5° of overlap is shown with the surrounding quadrangles. The symbology is provisional and the final map will resemble the other published quadrangle geological maps of Mercury [1,2]. Unity Rupes is emboldened in the SE of the quadrangle.*