DIKES ON MARS: (1) WHAT TO LOOK FOR? (2) A FIRST SURVEY OF POSSIBLE DIKES DURING THE MARS GLOBAL SURVEYOR AEROBREAKING AND SCIENCE PHASING ORBITS. D. Mège, Département de Géotectonique, ESA CNRS 7072, case 129, Université Pierre et Marie Curie, 75005 Paris, France, e-mail: dmege@lgs.jussieu.fr).

Introduction: The tectonic importance of dikes on terrestrial planets in mantle plume contexts has been increasingly recognized, for the Earth (e. g., [1]) as well as for Mars [2-6], Venus [7-11], and the Moon [12]. Evidence of dikes on other planets is generally indirect and rest on geomorphologic observations at grabens. The resolution of the MGS/MOC images will allow direct observation of dikes and their relationships to structural patterns and distribution of volcanism. This paper discusses clues of dike outcrops that may be observed on MOC images, and gives examples of possible dikes observed during the aerobreaking and science phasing orbits. It must be pointed out, however, that because of the absence of a regional context at a similar resolution, these interpretations are by no means definitive.

What to look for?

Dike distribution and geometry. Most of the dikes we are looking for are radial about the Tharsis central area (Syria Planum, Tharsis Montes, Alba Patera, maybe Thaumasia [3]). However, concentric dikes are also expected around the main volcanoes [4, 6]. Switching between radial and concentric geometry is expected as a result of the superimposition of various stress fields during intrusion (e. g., [13]). For similar reasons, dikes can transform into sills and reciprocally without any major change in stress sources [14, 13]. They are to transport magma laterally over hundreds or thousands of kilometers through interconnected segments, and therefore must have a mafic (maybe ultramafic?) composition to have a low viscosity. Good analogs are thought to be the 2500 km long Mackenzie dolerite dike swarm, composed of segments of mean width 30 m, and maximum width hundreds of meters.

Graben morphology, pit crater chains etc. Dike propagation at depth affects the morphology at surface. Such morphologies have been studied in detail on Viking images [2, 15, 3]. The MOC images will help understanding these processes into more detail.

Narrow, symmetrical and linear low relief ridges. This is the most common way for finding dike exposures. The difference between most outcropping faults and dikes is that both dike sides have steep slopes. The base of the slope has a lower angle due to debris accumulation.

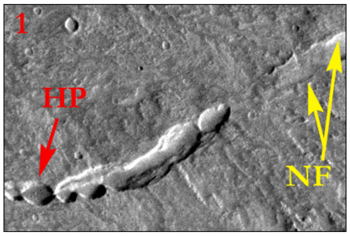
However, dikes may also form cliffs. Field work in the Tertiary province in Greenland during summer 1998 revealed a dolerite dike tens of m wide at Ilivtîlaq Island (eastern Greenland) forming a cliff 400 m high on one side, whereas it is only 10-20 m high on the other side. Such a dike might be taken for a fault on a satellite image.

Promontories on cliff walls. Geomorphologic [16], structural [17], and geochemical [18] evidence suggests that most dikes in mafic swarms are non emergent. Icelandic dikes are generally observed at depths greater than 1 or 2 km. Valles Marineris should provide cliffs and slopes high enough to allow observation of non emergent dikes on the walls. NE-SW and NW-SE oriented linear crest lines in Ius Chasma aligned with the Louros Valles sapping channels are potential dikes that need more accurate study using MOC images to be firmly identified. However, the dike swarm identified by Mège and Masson [3] in the Valles Marineris region are parallel to the chasmata. Therefore most dikes are not expected to be observed across the chasma walls. Evidence should be searched for in the oblique valleys dissecting the chasma walls.

Observing mafic dikes in other regions may thus require rather high slopes, or that erosional processes were especially efficient, otherwise they can only be detected by their geomorphologic effect at surface, including e. g. spatter cones and magma-volatile interaction morphologies. Given these restrictions, some of the of the best areas to look at may include Noctis Labyrinthus, and outflow and sapping channels.

Albedo. Erosion under both glacial, periglacial, and hot arid climate gives brownish dolerite dikes, corresponding to middle-dark Grey on high resolution MOC images.

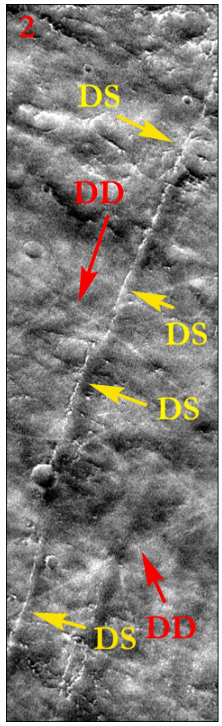
Narrow dike depressions. Dike propagation sometimes causes metamorphism of the host rock. Sandstone can be metamorphosed to quartzite. In the Makhtesh Ramon dike swarm of the Neguev (Israel), host rock strengthening by metamorphism, together with dolerite dike kaolinisation, could locally remove the entire dike topography, and may result in vertical-sided narrow depressions of geometry directly controlled by the dike geometry. Evidence of such depressions on Mars would provide strong clues for a warmer climate in the past.



Linearity. At regional scale, mafic dike trends are reliable indicators of minimum principal stress trajectory (e. g., [19]). However, locally, mafic dikes often follow local fractures and are influenced by local stress field [20-22]. Dike linearity thus depends on the scale considered, and is not a reliable means for distinguishing dikes from purely tectonic fractures.

Survey of 1997-1998 MOC images:

About 15 images in which possible dikes could be found. Table 1 indicates the location of some of them. Four examples of possible dike occurrences are given on fig. 1-4. Resolution ranges between 3 and 10 m/pixel. The scale is not available, however, the images should not be more than several km across. North orientation is not determined.



picno	lat N	lon W	picno	lat N	lon W
1707	-11.92	119.59	41505	-6.56	100.23
11804	1.18	114.17	52204	24.69	114.07
26703	26.05	101.54	54303	14.16	83.68
26704	14.82	103.23	54304	17.05	84.11

Table 1: Location of some 1997-1998 MOC images displaying possible dikes.

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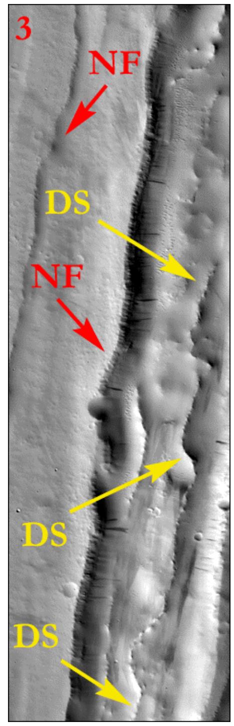

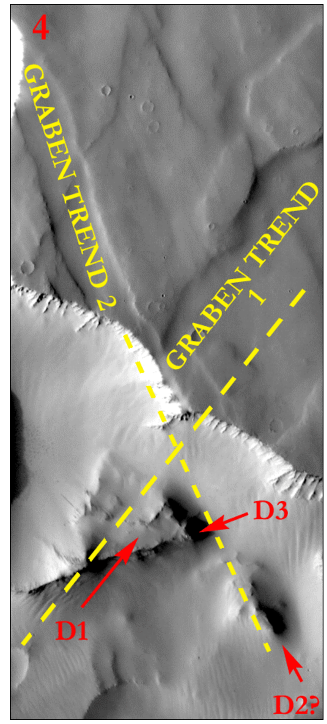

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Figure captions:

Figure 1 (MOC 1707, Tharsis region): Pit chain alignment and ovoid depression interpreted as hydrovolcanic pits (HP) around an elongated caldeira aligned with a graben (NF: normal fault).

Figure 2 (MOC 11804, Tharsis region). Dike segments (DS) and possible dust devils (DD) can be distinguished by the positive relief of dike segments.

Figure 3 (MOC 26703, Tharsis region): Dike segments (DS) within a graben (NF: normal fault).

Figure 4 (MOC 41505, Noctis Labyrinthus): Two dikes aligned with grabens and a third one (D1, D2, D3).