INTERPRETING REMOTE SENSING DATA: MARTIAN DIKES VS. OTHER FEATURES.
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Introduction: Planetary geology, especially morphological analysis of remote sensing images, often discusses features which can be interpreted in many ways. The scientific analysis relies on the evidence that is a) observable in nature, b) observable with contemporary data, and c) taken into account by the scientists studying the features.

The primary purpose of this abstract is to remind that all, even the less likely explanations for the studied landforms should be investigated, since a multitude of processes may result in apparently similar morphology. As an example, our survey of magmatic dikes [1, 2] is used. This abstract is additionally intended as supplementary to [1]: Here, Table 1 lists various processes and resulting structures that may be (mis)interpreted as magmatic dikes. The identification problems are discussed here, while [1] concentrates on the findings and interpretations of the regional survey. The feature lists consist of textbook examples of various processes and structures, each of which has been extensively studied by researchers other than myself. Unfortunately citing them all would be impossible. The table are by no means intended to be all-inclusive or exhaustive, but aimed to show a peek into the issue.

Interpreting remote sensing data: In geology, varying processes can result in similar landforms. For example, a roughy linear ridge may result from tectonic compression, glacier retreat, fluvial activity, magmatic intrusion or eolian deposition (Table 1). With hands-on studies the interpretation of such features may be easy on Earth. In planetary science, using only remote sensing data, finding the correct process is often harder and requires delicate work. This is the case most of all with bodies such as Mars, which have complex environments with atmospheric, fluvial and solid surface processes. In addition, the Martian climate changes are much larger than those of the Earth [3]. To top this, with no tectonic surface recycling, all the evidence is left in situ to be modified by later processes. Interpreting Martian surface features and deducing global conclusions from small-scale studies can thus be quite troublesome. If caution is not exercised, the result may lead the study astray.

Example – identifying dikes: These concerns are especially important in the search for magmatic dikes on the east Hellas basin rim on Mars [1,2]. The basin is surrounded by a large volcanic province [e.g. 4,5]. Tthe region has undergone a multitude of pre-, syn- and post-volcanic processes, e.g. significant erosion [1,2] as well as deposition by glacial processes [6-8]. All this has resulted in a structures mix, side by side, with formation ages millions to billions of years apart. During this time in between the environment has probably changed drastically [3], and thus interpretation of features should take also the currently not-so-obvious possibilities into account.

Conclusions: The correct deciphering of geological features – or any feature or phenomenon in nature for that matter – relies on the exhaustive detective work of the scientist. Even the alternatives that first appear improbable should be investigated, to prove or disprove evidence or lines of thought.

References: [1] Korteniemi et al. (2009) LPSC XXXX, this issue. [2] Korteniemi et al. (2009) *EPSL*, subm. [3] Laskar et al. (2004) *LPSC XXXV*, 1600. [4] Williams et al. (2008) *PSS, doi:10.1016/j.pss.2008 .08.010.* [5] Williams et al. (2009) *EPSL*, subm. [6] Squyres (1979) *JGR, 84*, 8087. [7] Pierce & Crown (2003) *Icarus, 163*, 46. [8] Korteniemi et al. (2007) *7th Mars Conf.*, 3821.

Table 1: Processes forming features which may be interpreted as dikes.

*** Roughly linear ridges**

Process type	structure name	formation requirements	typical characteristics
Tectonism	wrinkle ridges	layered strata, compression	sinuous, discontinuous
Tectonism	block margins	fractured / tilted blocks	fractured / tilted block margins
Mass wasting	deposit margins	disturbed slope materials	parallel to adjacent massif/wall
Volcanism	lavaflow margins / fronts	lava source; volcano, fissure	lobes follow topography (roughly)
Volcanism	magmatic dikes	exhumation of dike body	long, linear, often in swarms
Fluvial	shoreline	basin, standing water body	parallel to topography contours
Fluvial	floor features	water, slope, sedimentary materials	follow topography, sinuous, sometimes braiding, often discontinuous
Fluvial	inverted channels	water, slope, sediment consolidation, exhumation	follow topography, sinuous, sometimes braiding and/or discontinuous

Periglacial	patterned ground	permafrost conditions	polygonal structures, stripes
Glacial	lineated valley fill, lobate debris aprons	source of volatile-rich sediments, slope	alternating ridges / troughs, follow topography, lobate margins, viscous flow features
Glacial	eskers	retreating glacier	sinuous, often not parallel to topography contours, sometimes discontinuous
Glacial	moraines	retreating glacier with carried sediments	hummocky, sinuous, parallel to topo contours, largest at maximum extent of glacier
Glacial	drumlins / fluting	glacier movement	swarms, parallel, teardrop shaped
Eolian	linear dunes	deposition, bi-direct. wind	slightly sinuous
Eolian	well-developed yardangs	erosion, one wind direction, abrasive sediments	discontinuous
Sedimentation	clastic dike	fracture fill by sedimentary materials, later exhumation	follow original, often surficial fracture pattern; often short and chaotic
Impact	ejecta	possibly lobate ejecta or erosion	roughly crater-radial or -concentric ridges

*** Roughly linear depressions / troughs**

Process	**structure type**	**formation requirements**	**typical characteristics**
Tectonic	fracture / graben	extension of local surface	long, linear, continuous
Volcanism	magmatic dike	magma penetration to near-surface	shallow graben or fracture, swarm points to or is concentric to volcanic center
Volcanism	lava tube	magma source, collapse	near volcanic edifice, on lava plains
Fluvial	channel	water source, erosion	sinuous, follow topography, basic V-shape
Permafrost	patterned ground	permafrost conditions	polygonal structures, troughs
Eolian	poorly developed yardangs	erosion, one wind direction, abrasive sediments	discontinuous
Glacial	lineated valley fill, lobate debris aprons	source of volatile-rich sediments, slope	alternating ridges / troughs, follow topography, lobate margins, viscous flow features
Glacial	U-valleys	glacial tongue, carving of floor and sides	wide valley, cross-section U-shaped

*** Pit chains**

Process	**structure type**	**formation requirements**	**typical characteristics**
Tectonic	extension fractures	extension, multipart	pit chain in graben
Volcanism	lava tube	magma source, partial coll.	near volcanic edifice, on lava plains
Volcanism	phreatom. eruption	intrusion into water-rich soil	explosion crater, pseudocraters?
Dissolution	karst	soluble rock, acidic water	limestone basement, wide area?

*** Cone-line features**

Process	**structure type**	**formation requirements**	**typical characteristics**
Periglacial	pingo	earth-covered ice	fractures on top, after melting pit in center
	mud volcano	pressurized mud in substr.	in areas of local or regional tectonics?
Eolian	well-developed yardangs, mesas	weathering, erosion, abrasive sediments	flat-topped, often sedimentary
Volcanism	spatter cone	volcanic vent, lava spatter	irregular shapes
Volcanism	tuya	volcanic vent under glacier	flat-topped
Volcanism	cinder cone	volcanic vent, tephra	summit crater

*** Roughly vertical lineations in cross-sections**

Process	**structure type**	**formation requirements**	**typical characteristics**
Tectonic	fracture	extension, tension	shifting of cut strata
Sedimentary	clastic dike	previous fracture, sediments	shifting of cut strata, filling of fracture
Volcanic	magmatic dike	magma penetration into rock	varying color, often wide, resistant