

Determining paleoflow direction of martian channel belts using preserved channel-bend asymmetry:



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1. Introduction

- inverted fluvial channel belts at Aeolis Dorsa, Mars, (Fig. 1) indicate a warm, wet period of martian history [1-4]. An ocean may have existed in the northern lowlands [5-12]
- Deltas and incised valleys indicate Aeolis Dorsa was coastal during this period [7,14,15].
- Aeolis Dorsa is located at highland/lowland transition where a coastline of an ocean may once have existed
- Modern regional slope is towards north, leading to assumption that paleoflow was towards the north [e.g., 13]
- paleoflow towards north is inconsistent with interpreted flow direction of deltas [7,14].

-Here, we develop a method to determine the paleoflow direction of inverted channel belts on Mars and apply it at Aeolis Dorsa to test the delta/coast hypothesis

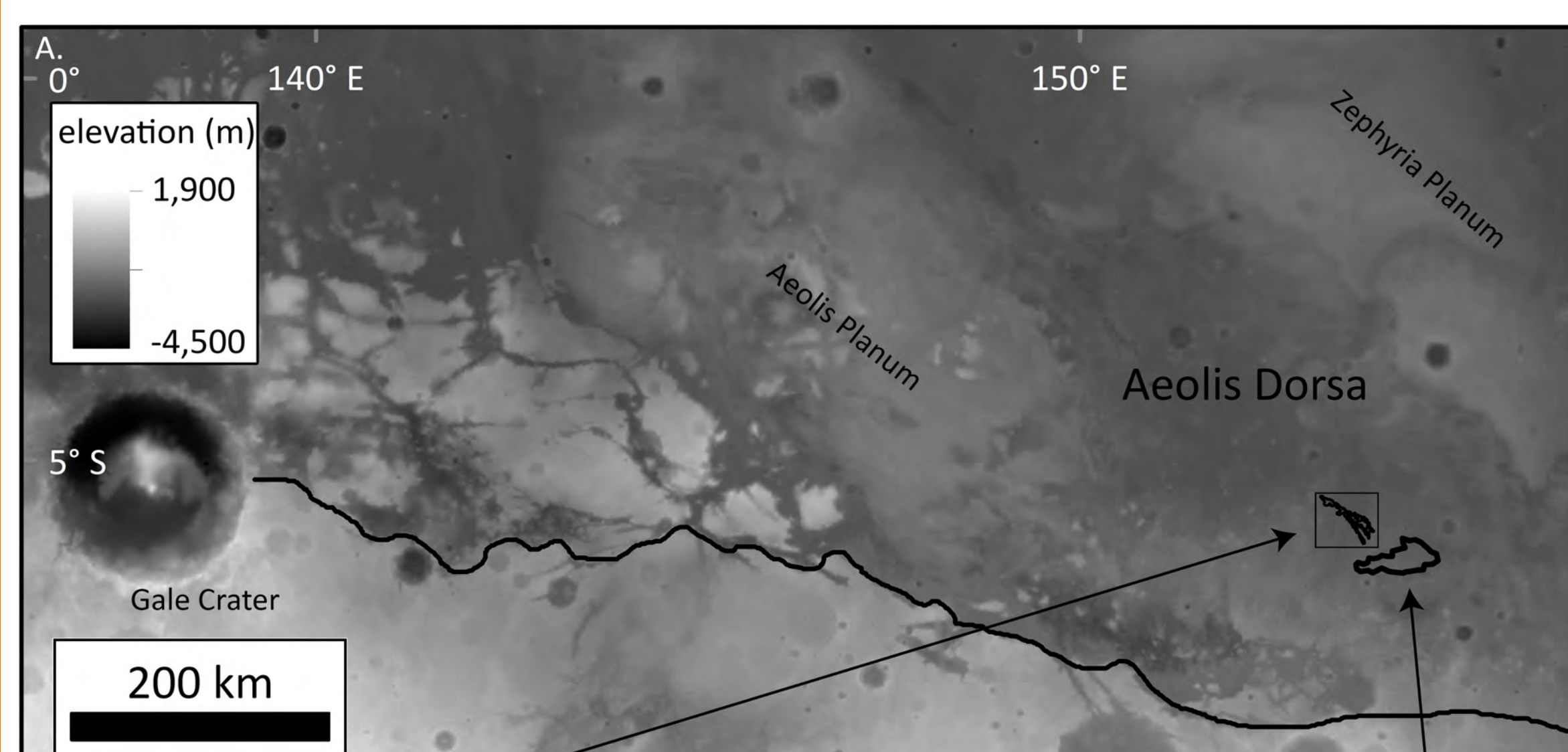


Figure 1 - Aeolis Dorsa is a topographic low surrounded by topographic highs (Aeolis and Zephyria Planum, ignimbrite). Arrows point to coastal deposits outlined in black [14-15]. Black line marks highland/lowland transition [16]

2. Methods

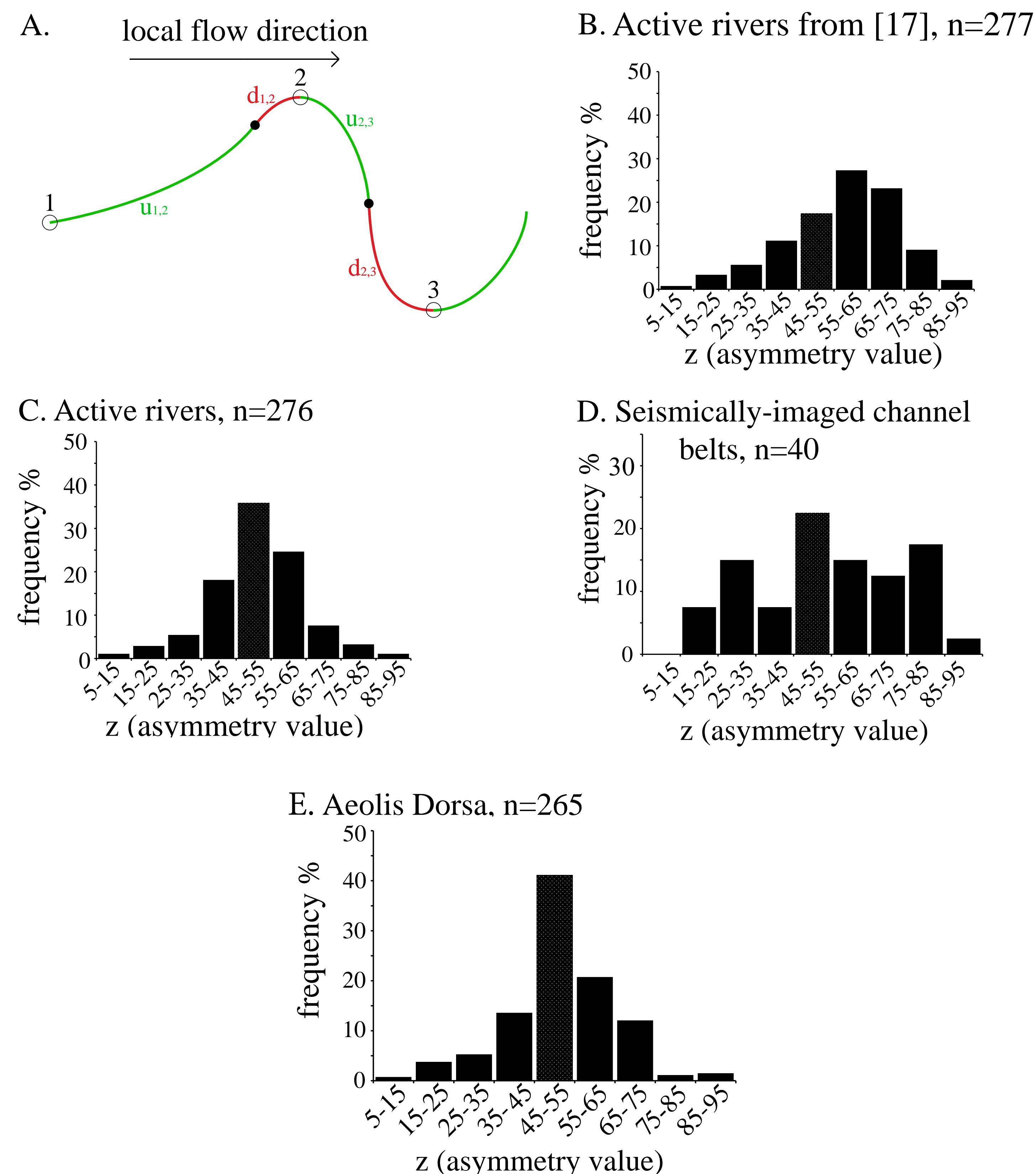
- [17] identified a flow direction-dependent planform asymmetry in active rivers (Fig. 2)
- we automate this measurement of asymmetry and test it on:
 - active rivers (Fig. 3A, known flow dir.)
 - seismically-imaged channel-belts preserved in subsurface Gulf of Mexico (Fig. 3B, known paleoflow dir.)
 - inverted channel belts across Aeolis Dorsa (Fig. 3C, unknown paleoflow dir.)

3. Results

- asymmetry exhibited in all datasets, though more subtly than in [17] (Fig. 3)
- asymmetry at Aeolis Dorsa correctly skewed if southeastern paleoflow dir. assumed (Fig. 3E)

Figure 2 - A: planview of hypothetical river centerline. Green is upstream concave (length = u), red is downstream concave (length = d). Adjacent green and red lengths are bound by curvature maxima and separated by an inflection point. [17] found that upstream concave portions of rivers tend to be longer than adjacent downstream concave portions (e.g., between points 1 & 2). **The degree of asymmetry is described by the asymmetry value, $z = 100*u/(u+d)$.**

B: Results for active rivers reported by [17]. C: Results for active rivers done for this work (Fig. 3A). D: Results for seismically-imaged channel belts (Fig. 3B). E: Results from inverted channel belts at Aeolis Dorsa (Fig. 3D)



4. Conclusions

- Asymmetry of channel belts at Aeolis Dorsa indicates southeastern paleoflow direction
- consistent with paleoflow dir. interpreted from deltas [7,14]
- consistent with Aeolis Dorsa as a paleo-coastal region to a large body of water [7,14,15], possibly an ocean in the northern lowlands
- refinement of automated asymmetry measurement may lead to more pronounced results

5. References: [1] Burr et al., 2009, Icarus, v. 200, p. 52-76, doi:10.1016/j.icarus.2008.10.014. [2] Burr et al., 2010, JGR, v. 115, E07011, doi:10.1029/2009JE003496. [3] Williams et al., 2013, Icarus, v. 225, p. 308-324, doi:10.1016/j.icarus.2013.03.016. [4] Kite et al., 2015, Icarus, v. 253, p. 223-242, doi:10.1016/j.icarus.2015.03.007. [5] Baker 2009, GSA Special Papers, no. 453, p. 25-36. [6] DiAchille and Hynes, 2010, Nature Geoscience, v. 3, p. 459-463, doi:10.1038/ngeo891. [7] DiBiase et al., 2013, JGR: Planets, v. 118, p. 1285-1302, doi:10.1002/jgre.20100. [8] Head III et al., 1999, Science, v. 286, p. 2,134-2,137, doi:10.1126/science.286.5447.2134. [9] Moscardelli et al., 2012, GSA Today, v. 22, no. 8, p. 4-9, doi:10.1130/GSATG147A.1. [10] Moscardelli 2014, GSA Today, v. 24, no. 2, p. 4-10, doi:10.1130/GSATG197A.1. [11] Parker et al., 1989, Icarus, v. 82, p. 111-145. [12] Perron et al., 2007, Nature, v. 447, p. 840-843, doi:10.1038/nature05873. [13] Matsubara et al., 2015, Geomorphology, v. 240, p. 102-120, doi: http://dx.doi.org/10.1016/j.geomorph.2014.08.031. [14] Hughes et al, this conference, abstract #2139, poster location 290. [15] Cardenas and Mohrig, 2015, 46th LPSC, abstract #2797. [16] Tanaka et al., 2014, USGS Scientific Investigations Map 3292. [17] Carson and Lapointe, 1983, The Journal of Geology, v. 91, p. 41-55. [18] Zeng and Hentz, 2004, AAPG Bulletin, v. 88, no. 2, p. 153-174.

Figure 3 - Unmapped and mapped centerlines from several datasets. Color scheme in Fig. 2A applies throughout. Blue arrows indicate flow or paleoflow direction. A: Beni River, Bolivia. B: Channel-belts preserved in the subsurface of the Gulf of Mexico, Tiger Shoal area [18]. C: Inverted channel belt at Aeolis Dorsa, CTX image B19_016981_1746.

