Testing crustal plateau formation models for Venus using geological mapping of Ishtar Terra marginal areas

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Problem

Crustal plateaus exposing tessera terrain have been identified on Venus. The origins of plateaus and tessera terrain are poorly understood.

Hypotheses and Predictions

We are testing five proposed models in this study: (Figure 1)

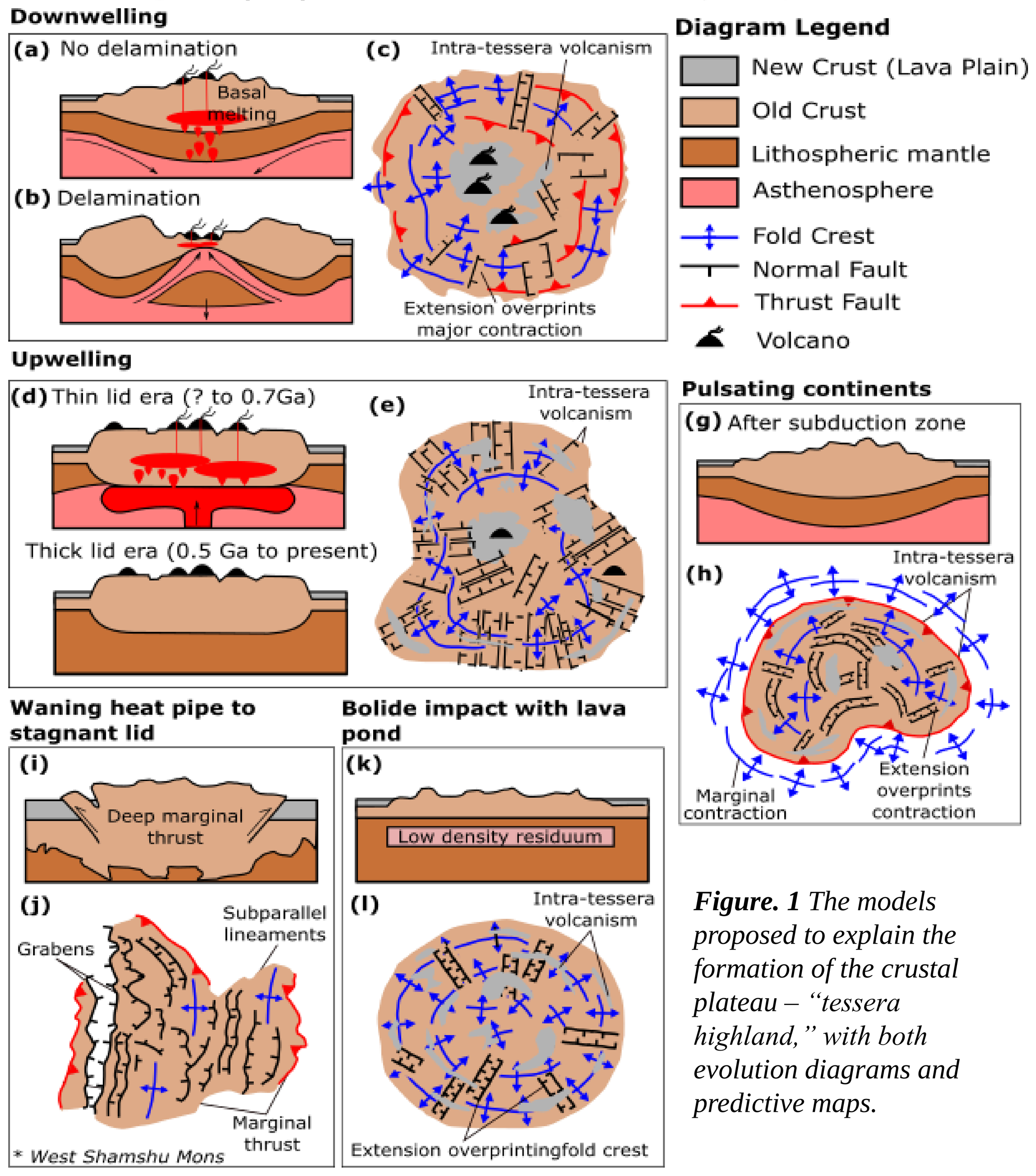

Figure. 1 The models proposed to explain the formation of the crustal plateau – "tessera highland," with both evolution diagrams and predictive maps.

Central differentiations of models are the surface deformation, marginal deformation, and tessera-plain onlapping relationship. (Table 1)

Model	Bounding Fault	Surface Deformation	Marginal Deformation
Downwelling [1]	Older than adjacent plains	Major contraction and late extension	Concentrated compression along elevated block edge
Pulsating Continents [2]			
Waning heat pipe to stagnant lid [3]			
Upwelling [4]	Mostly older than adjacent plains, but not in all places	Major extension, followed by minor contraction and late minor extension	Marginal extension
Bolide impact with lava pond [5]		Early fold crest and late extension	

Table. 1 Prediction of Venusian crustal plateau formation models.

Mapping Methods

- **Tessera** is a complexly deformed surface with at least two overlapping lineaments. [6] [7]
- **Lineament sets of deformation** (Figure 2)

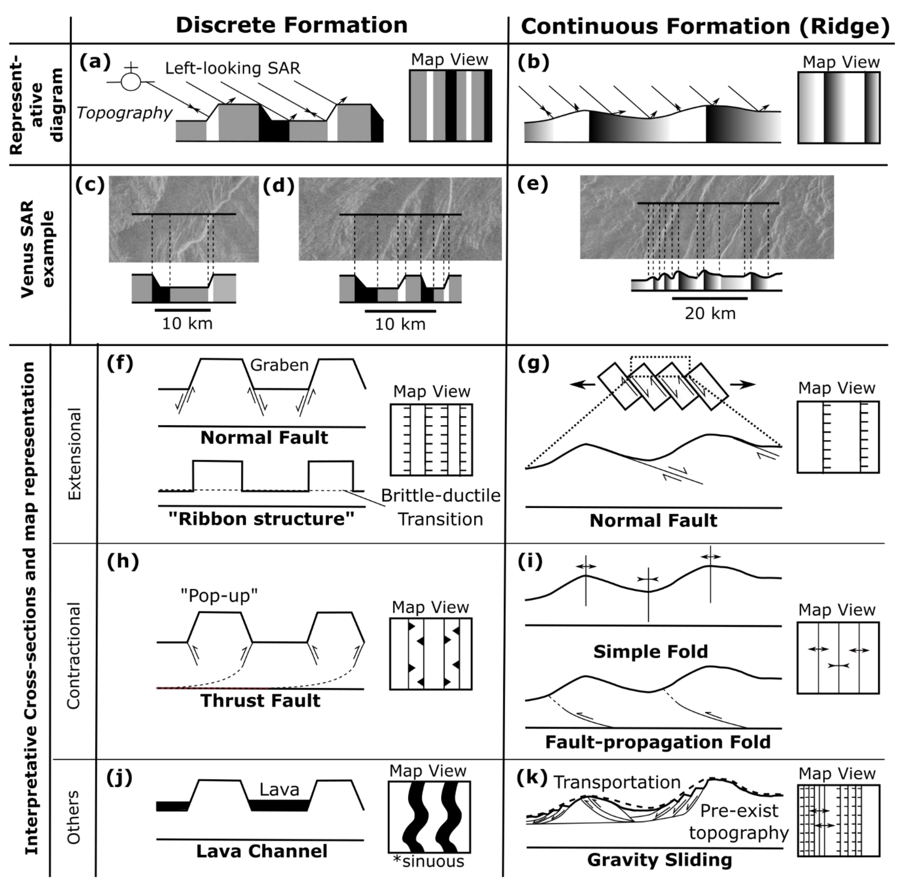

Figure. 2 Representative interpretative sketch cross-sections. Radar interactions with surface geology for both discrete fault (a) and continuous deformation (b), and their Venus SAR example (c). Interpretative cross-sections and map representation of structural interpretations (f – k).

Preliminary Results

We present detailed maps of Ishtar Terra's marginal areas. (Figure 3-5)

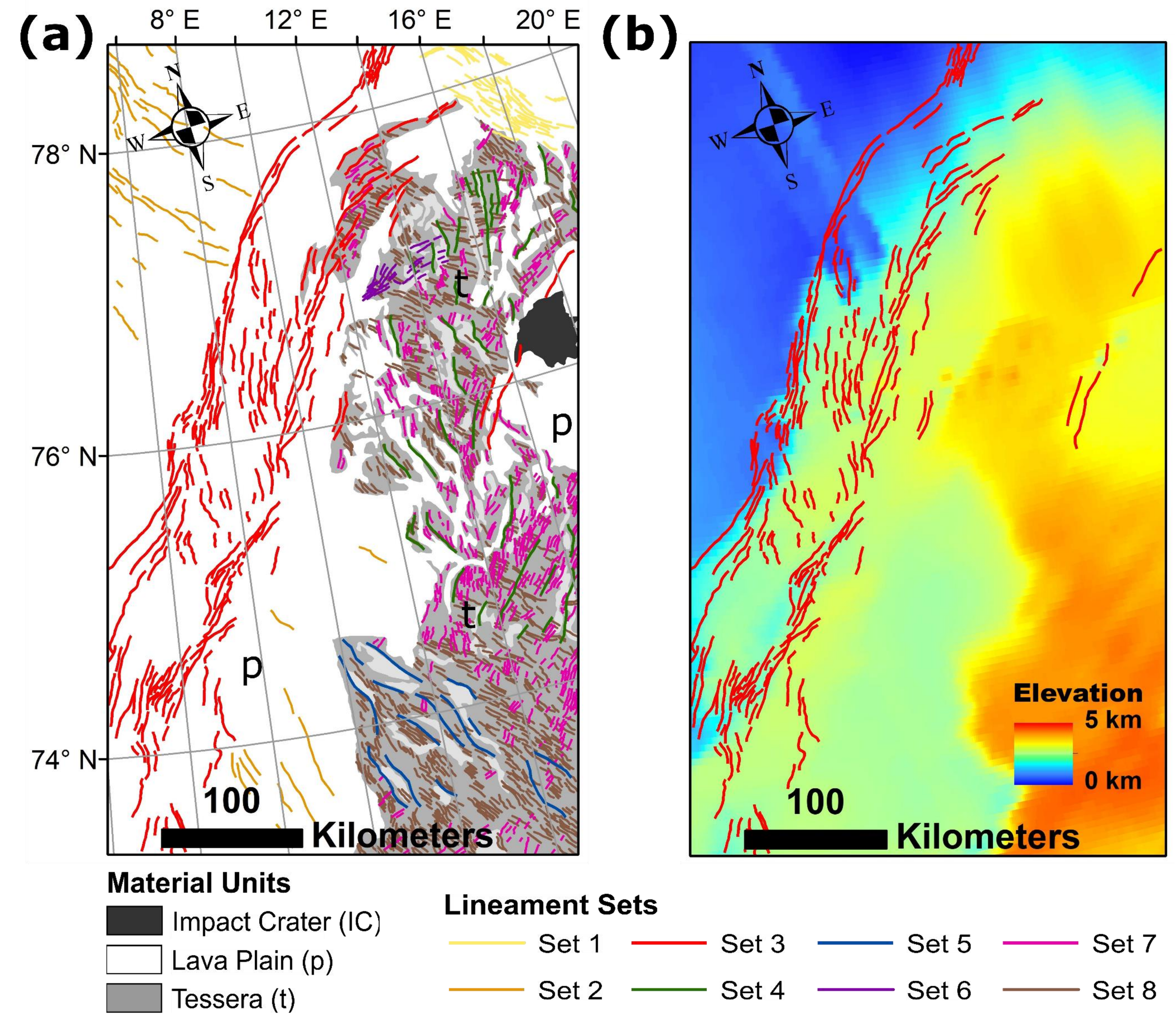

Figure. 3 (a) Detailed geological and (b) topographic map overlaid by lineament set 3 of northern Ishtar Terra margin. The elevation is above the mean planetary radius, 6051 km.

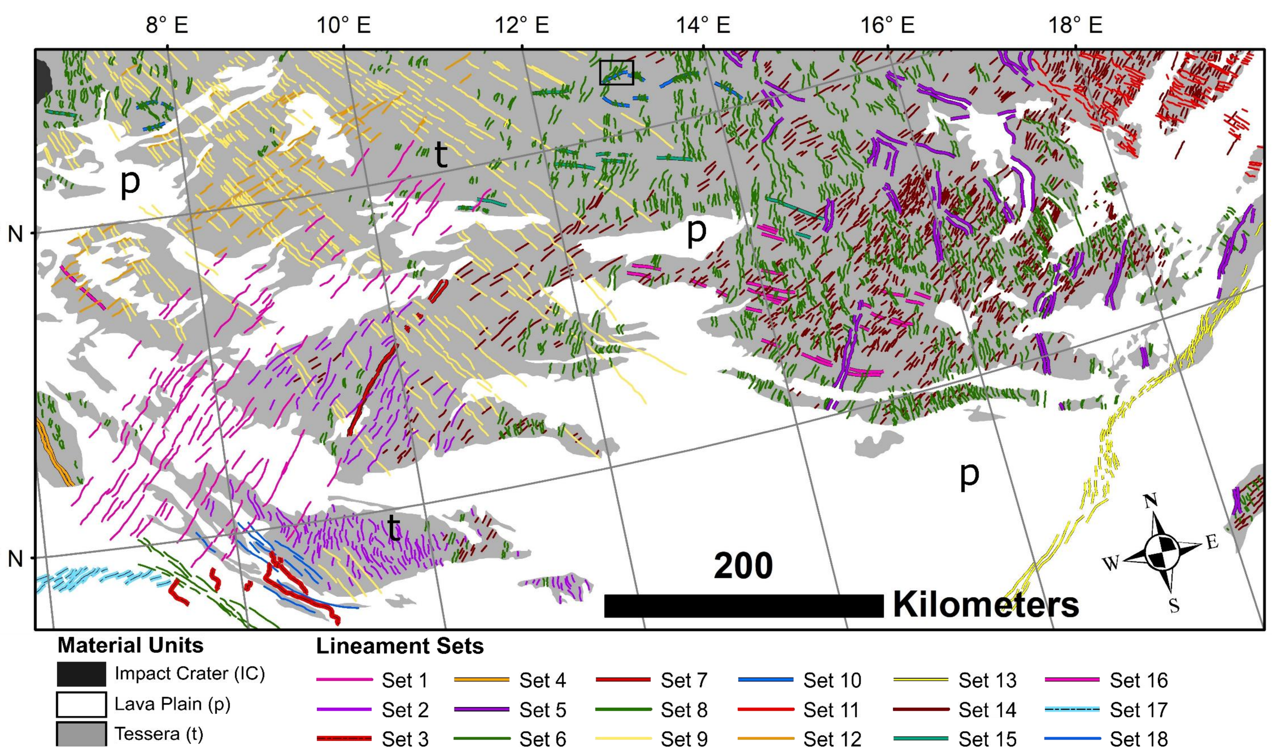

Figure. 4 Detailed geological map of southern Ishtar Terra margin. The black frame outlines Figure 6.

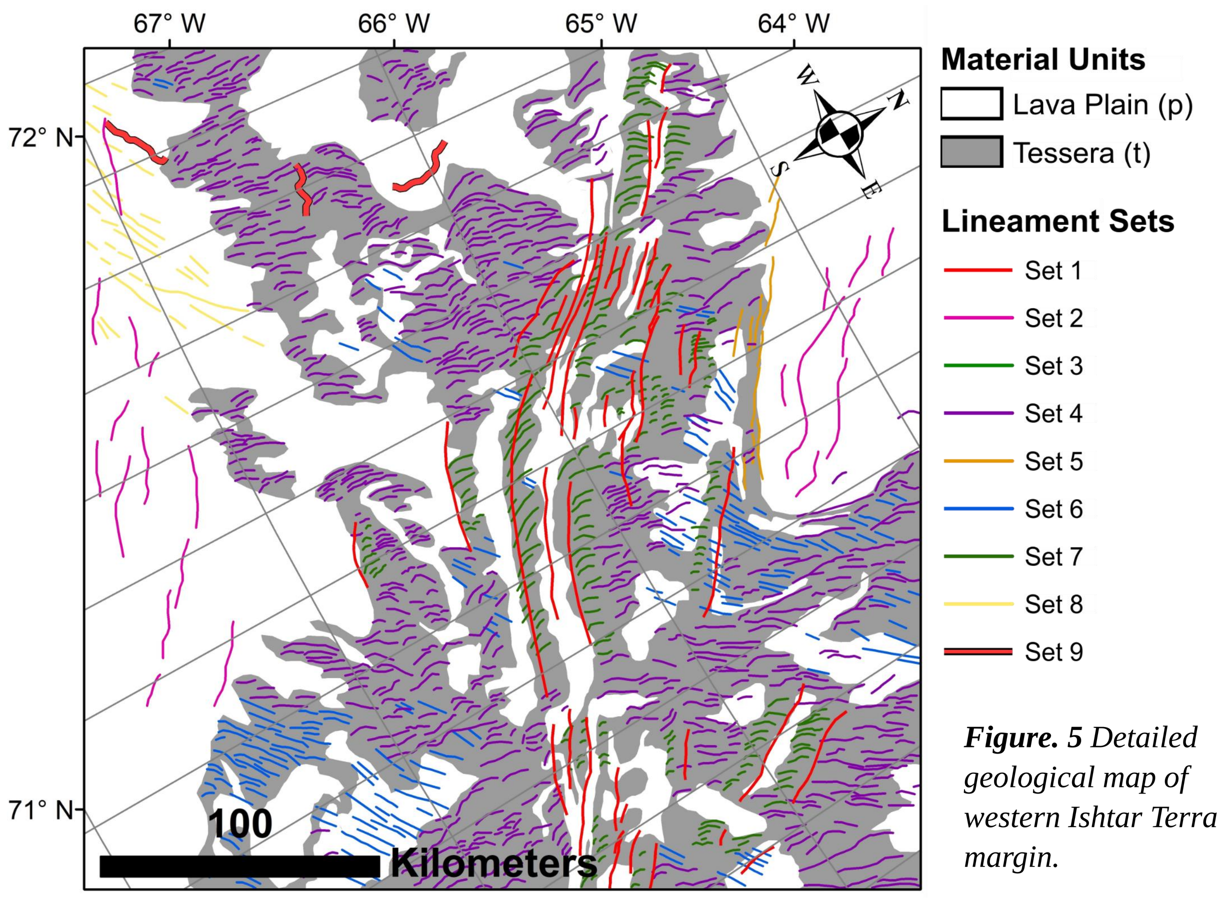

Figure. 5 Detailed geological map of western Ishtar Terra margin.

Our mapping identified a new structures: **V-shape faults**. (Figure 6)

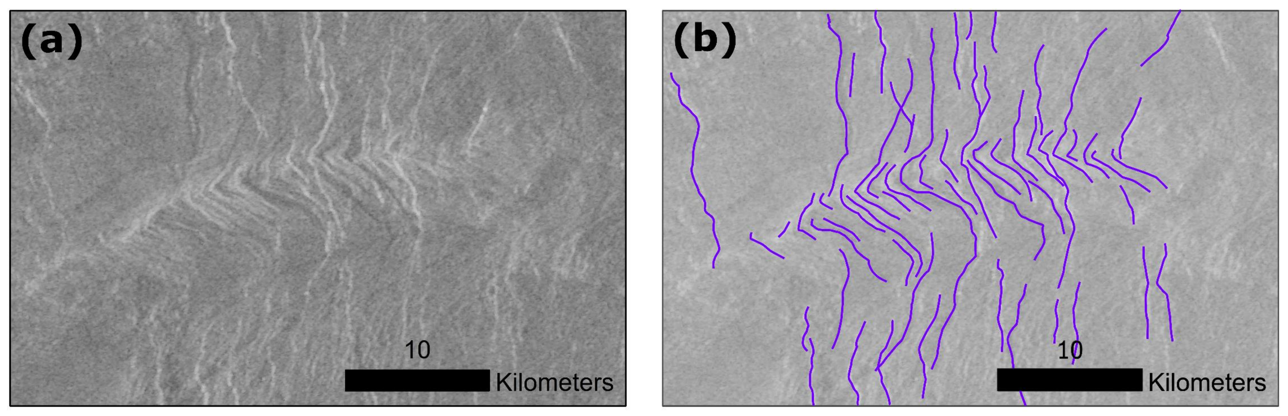

Figure. 6 SAR image (a) and mapped image of the V-shape faults.

Interpretations

We consider "end-member" interpretations of these areas. (Figure 7-9)

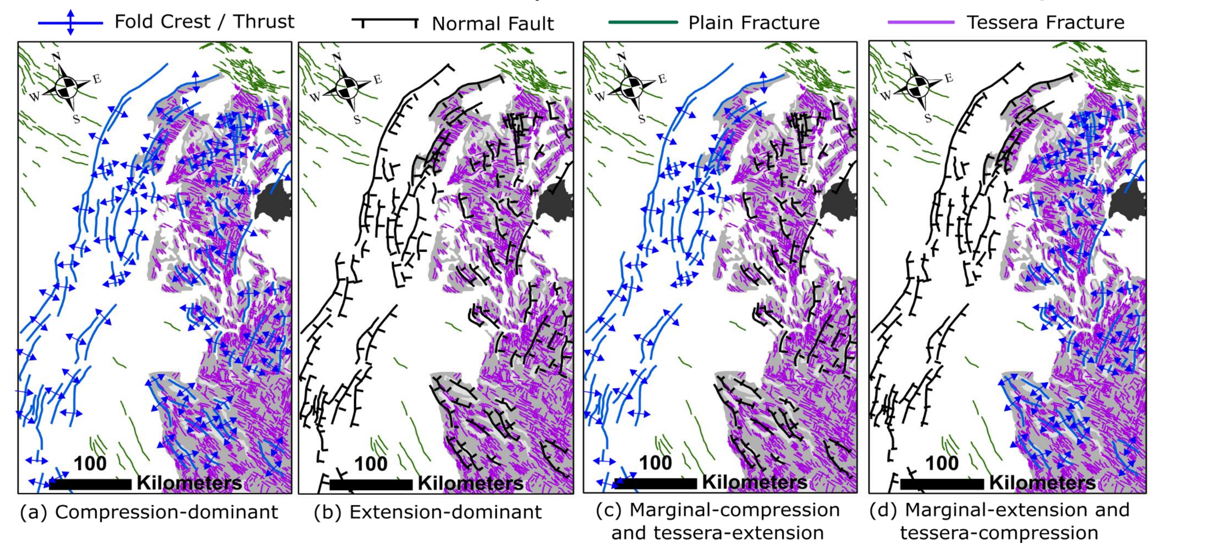

Figure. 7 End-member interpretative maps of the northern Ishtar Terra margin.

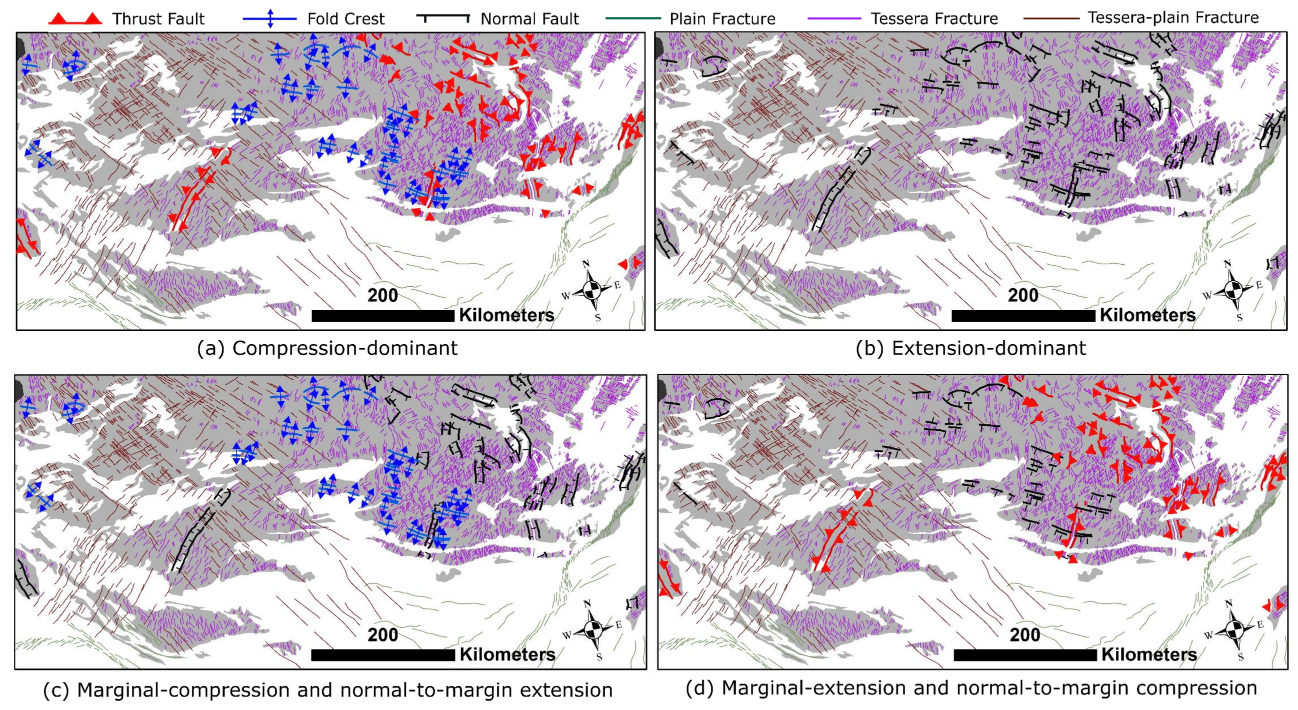

Figure. 8 End-member interpretative maps of the southern Ishtar Terra margin.

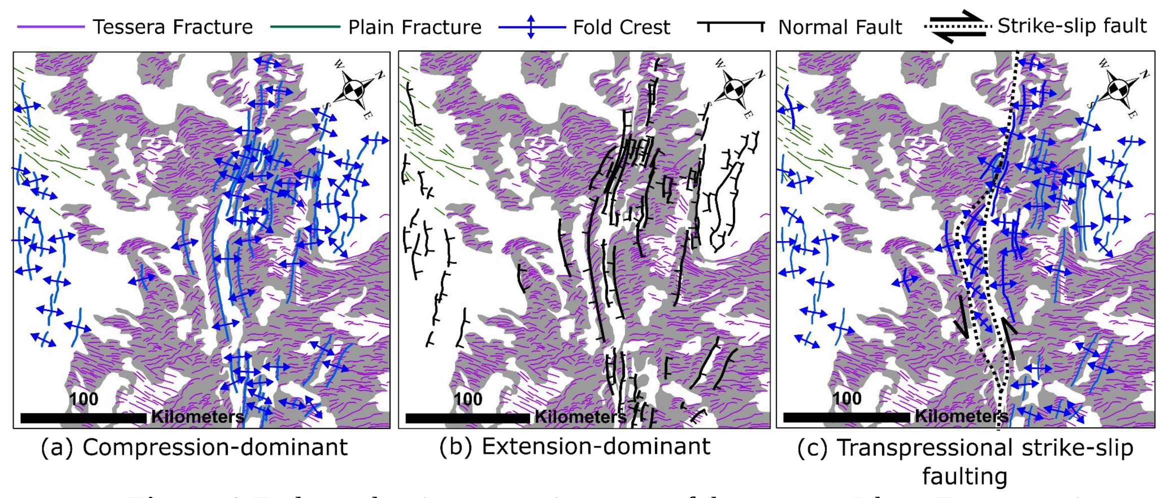

Figure. 9 End-member interpretative maps of the western Ishtar Terra margin.

- Thus, the mapping failed to falsify any existing models.

We consider two possibilities for the V-shape faults. (Figure 10)

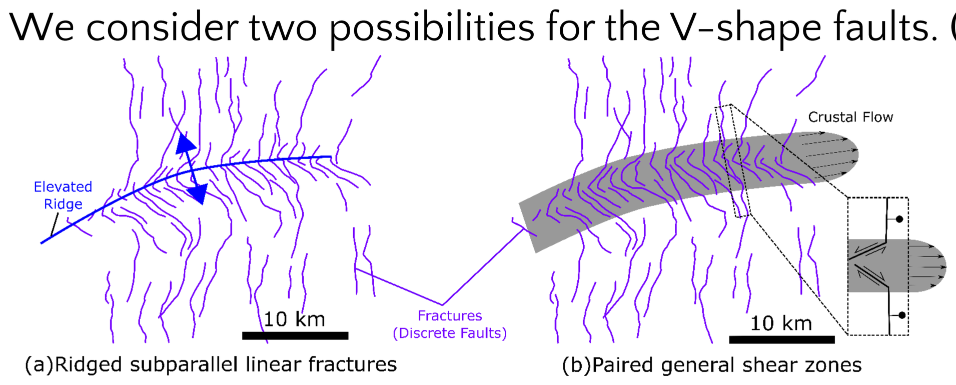

Figure. 10 The possible interpretations of mapped V-shape faults: ridged linear fractures (a) and paired general shear zone [8] (b)

Conclusion and Future Work

- We seek to test models by mapping to see which predictions are robust, but thus far the mapping fails to falsify any existing model.
- Future SAR data with 3-4 times higher resolution will be required to test the models. (Figure 11)

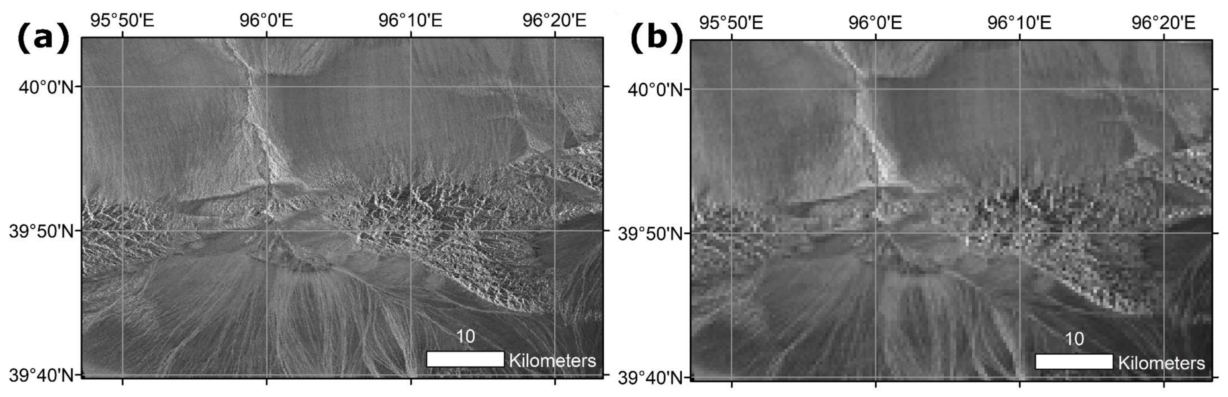

Figure. 11 Radar imagery of the Altyn Tagh fault with Magellan SAR resolution of 75 meters/px (a) and proposed resolution of 20 meters/px (b)

References: [1] Smrekar and Phillips. (1991). EPSL 107(3-4): 582-597. [2] Romeo and Turcotte. (2008). EPSL 276(1-2): 85-97 [3]] Moore et al. (2017). EPSL 474: 13-19 [4] Phillips and Hansen. (1998). Science 279(5356): 1492-1497. [5] Hansen (2006). JGR: Planets 111(E11). [6] Hansen and Willis (1998). Icarus 132(2): 321-343 [7]] Bindschadler and Head. (1991). JGR: Solid Earth 96(B4): 5889-5907. [8] Yin and Taylor. (2011). Bulletin 123(9-10), 1798-1821.