I: Maxwell's Constant-scale Surfaces

EXCERPTS FROM:
On Reciprocal Figures, Frames and Diagrams of Forces
A method for calculating stress in a structure 1869

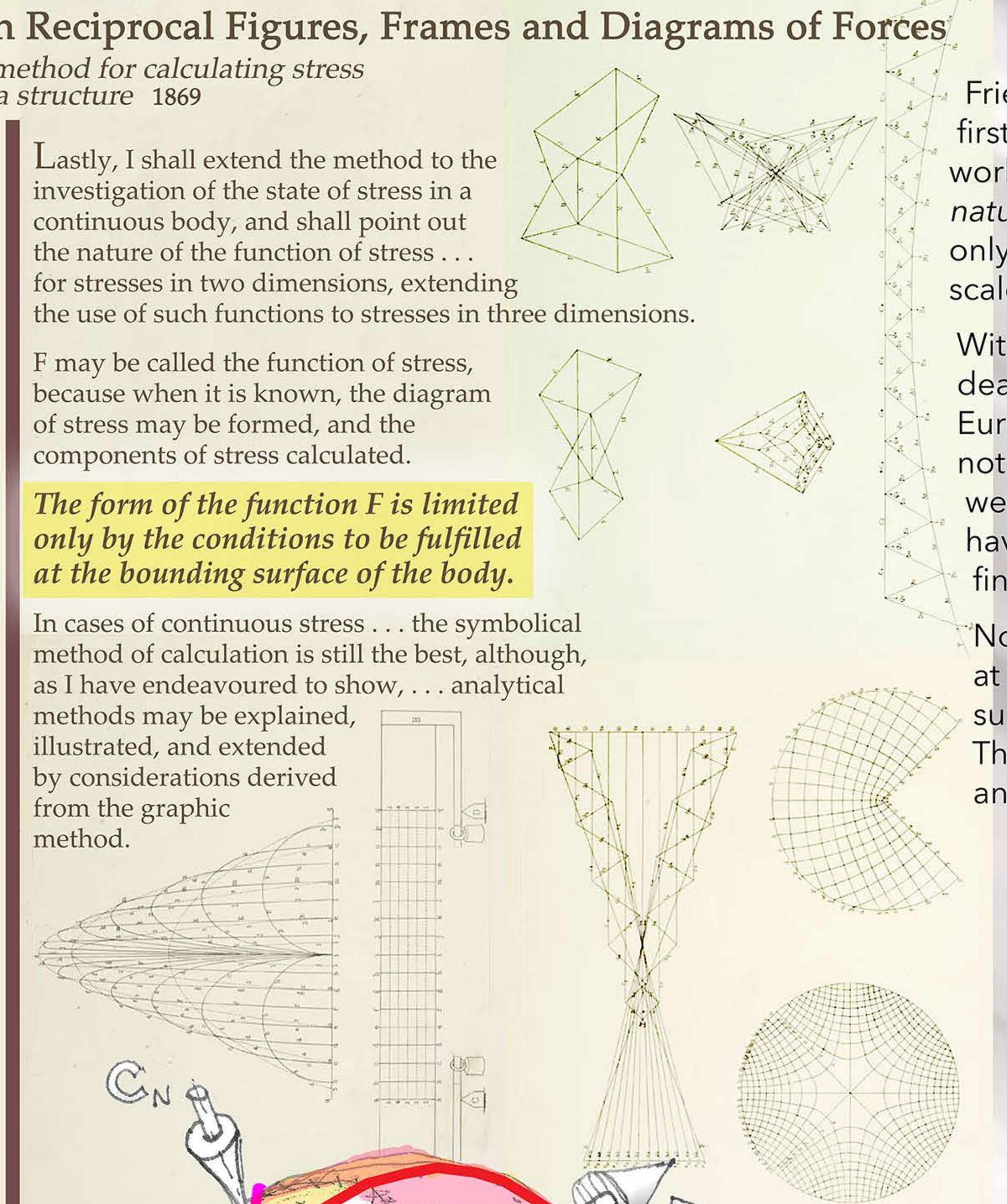
Lastly, I shall extend the method to the investigation of the state of stress in a continuous body, and shall point out the nature of the function of stress . . . for stresses in two dimensions, extending the use of such functions to stresses in three dimensions.

F may be called the function of stress, because when it is known, the diagram of stress may be formed, and the components of stress calculated.

The form of the function F is limited only by the conditions to be fulfilled at the bounding surface of the body.

Our emphasis

In cases of continuous stress . . . the symbolical method of calculation is still the best, although, as I have endeavoured to show, . . . analytical methods may be explained, illustrated, and extended by considerations derived from the graphic method.



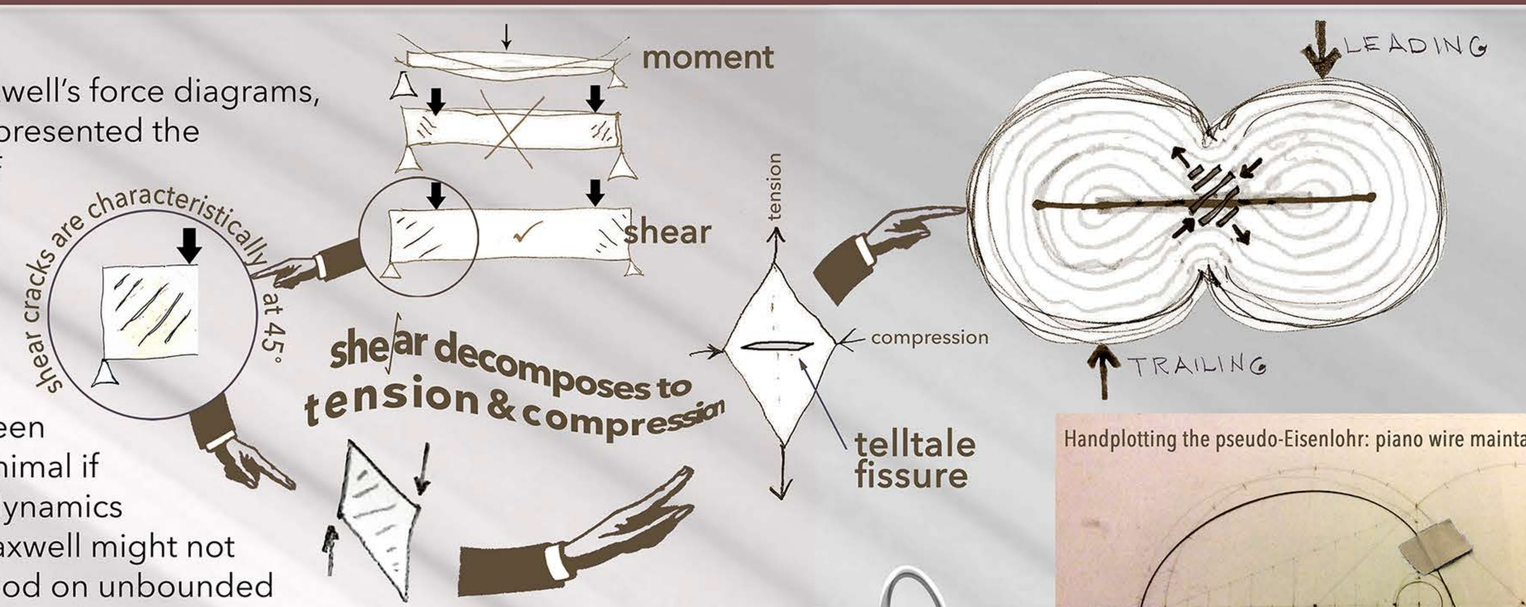
James Clerk Maxwell (1831–1879), *Transactions of the Royal Society of Edinburgh*, Vol. 26, pp. 1-40

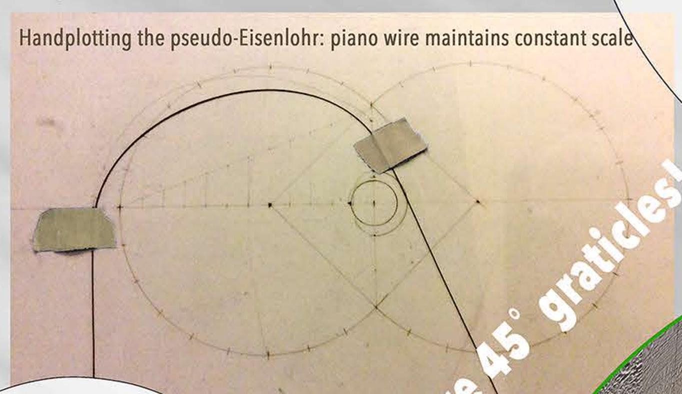
II: Beam Shear as Tiger Stripe Analogue

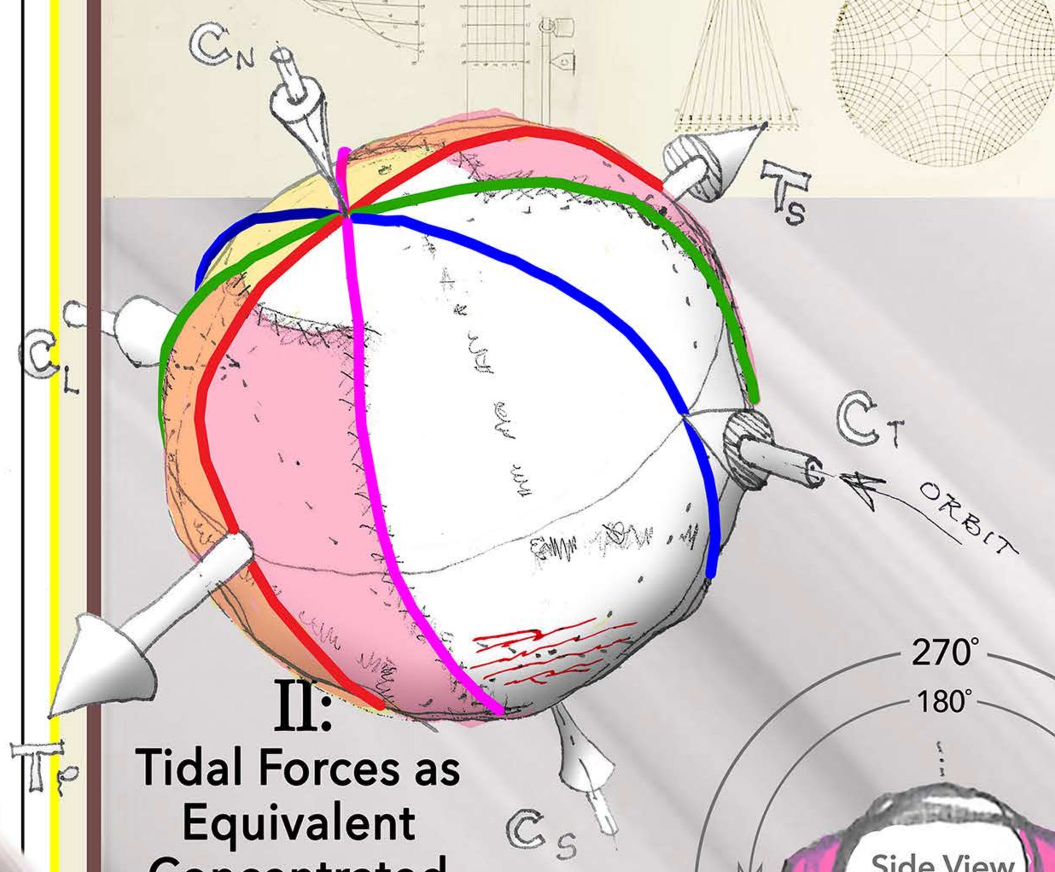
IN 1870, ONE YEAR AFTER Maxwell's force diagrams, Friedrich Eisenlohr of Bohemia presented the first and, until the introduction of world maps with constant-scale *natural* boundaries in 1993, the only projection with constant-scale edge.

Within a decade, Maxwell was dead, scientific exchanges between Europe and Britain had been minimal if not adversarial, and Enceladan dynamics were of course unsuspected. Maxwell might not have considered trying his method on unbounded finite surfaces embedded in a normal gravitational field.

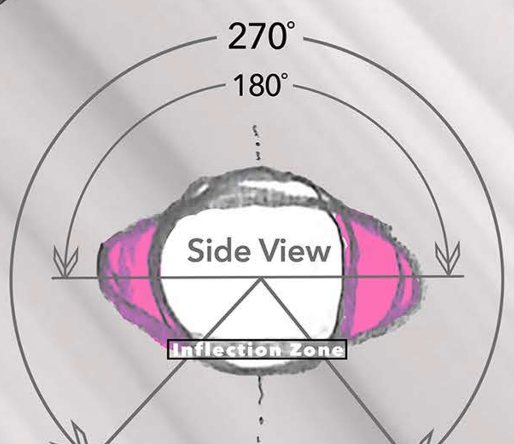
Now, graphic stress analysis of complex surfaces in a superposed field is common—at least among architects and mathematicians—but the application to developed surfaces of icy satellites may be novel. We try in Poster T326-425 (abs. #1044). This poster introduces maps invented for it, describes their design précis, and highlights their general felicity.







II: Tidal Forces as Equivalent Concentrated Loads



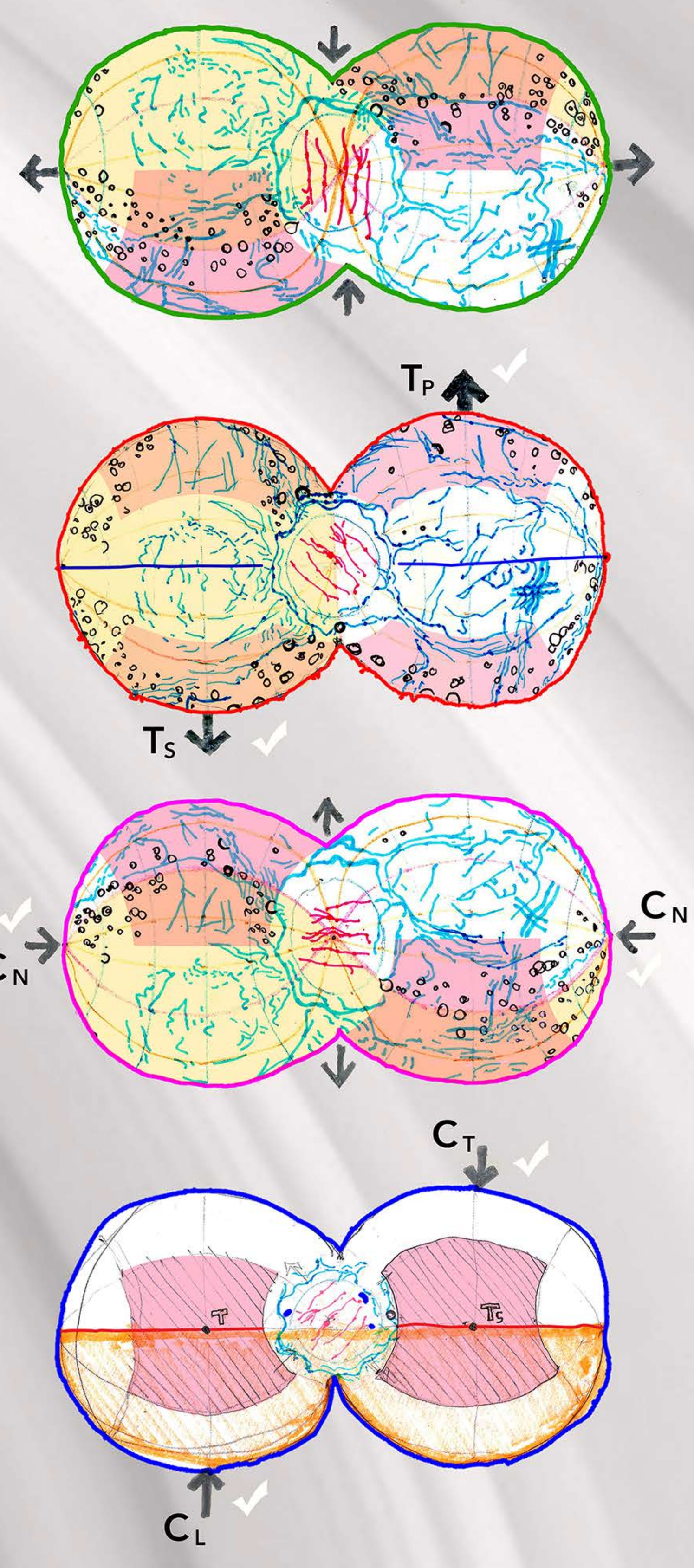
T_S tension toward stars
T_P tension toward Saturn
tension bulge
leading hemisphere

C_N compression @ north pole
C_S compression @ south pole
C_T compression @ trailing hemisphere
C_L compression @ leading hemisphere

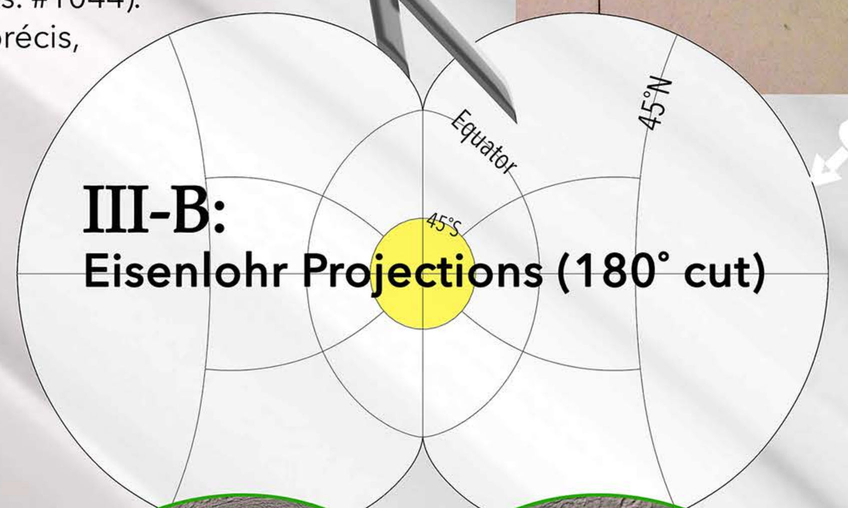
✓ checks *(at right)* indicate alignment of required shear vector with tidal vector

III: Constant-scale Projections as non-Euclidean Maxwell Surfaces

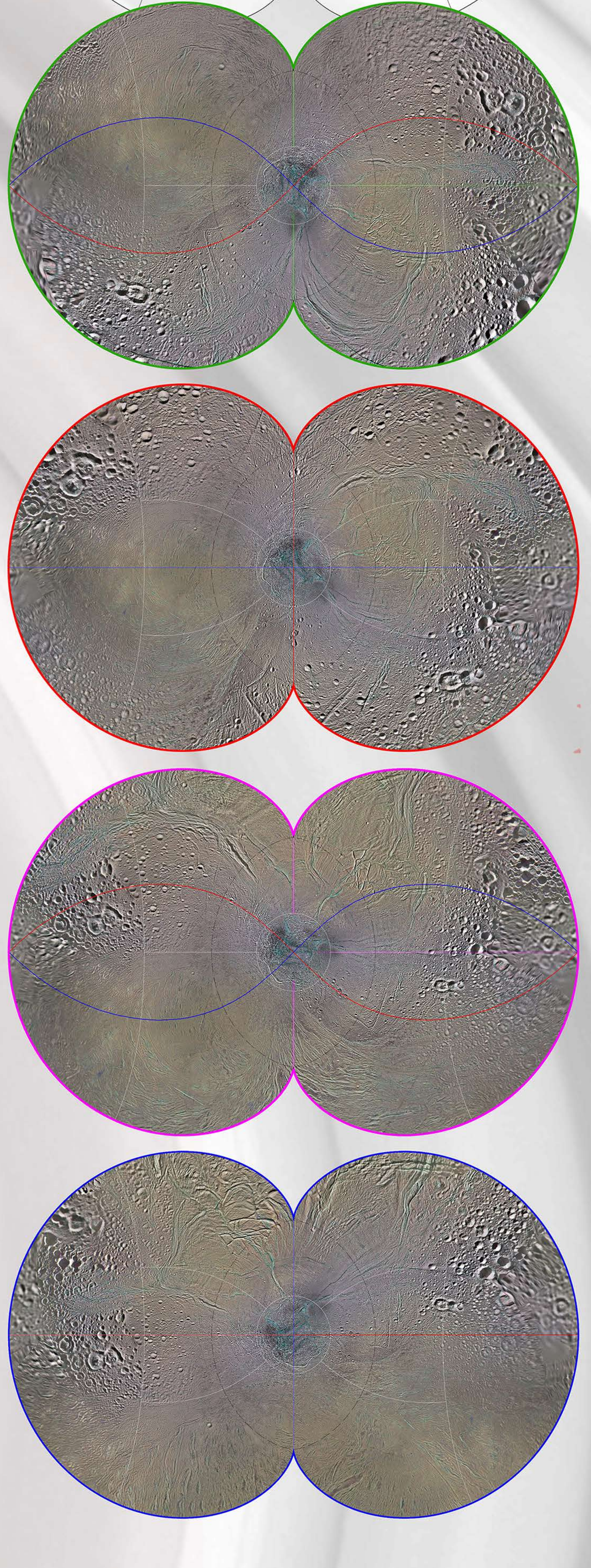
III-A: Possible Aspects for Tidal Stress-bound 270°-cut Projections



III-B: Eisenlohr Projections (180° cut)



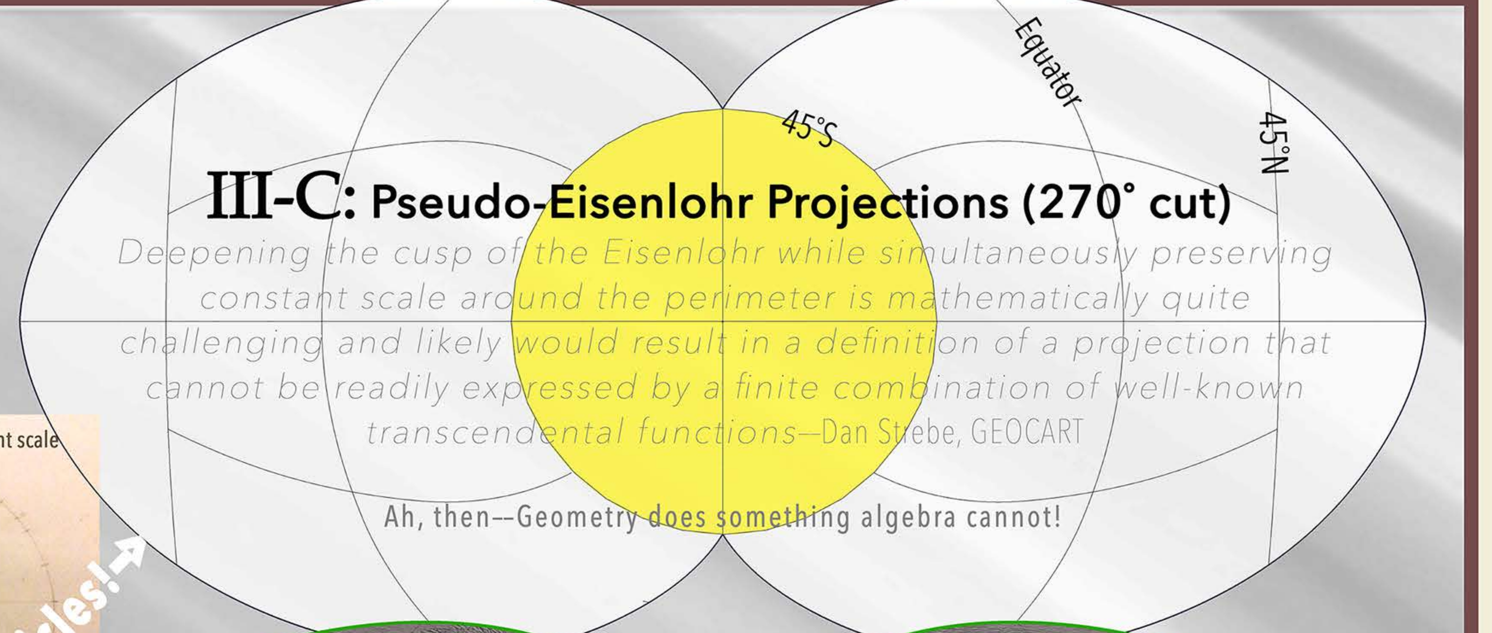
←Compare 45° graticles!→

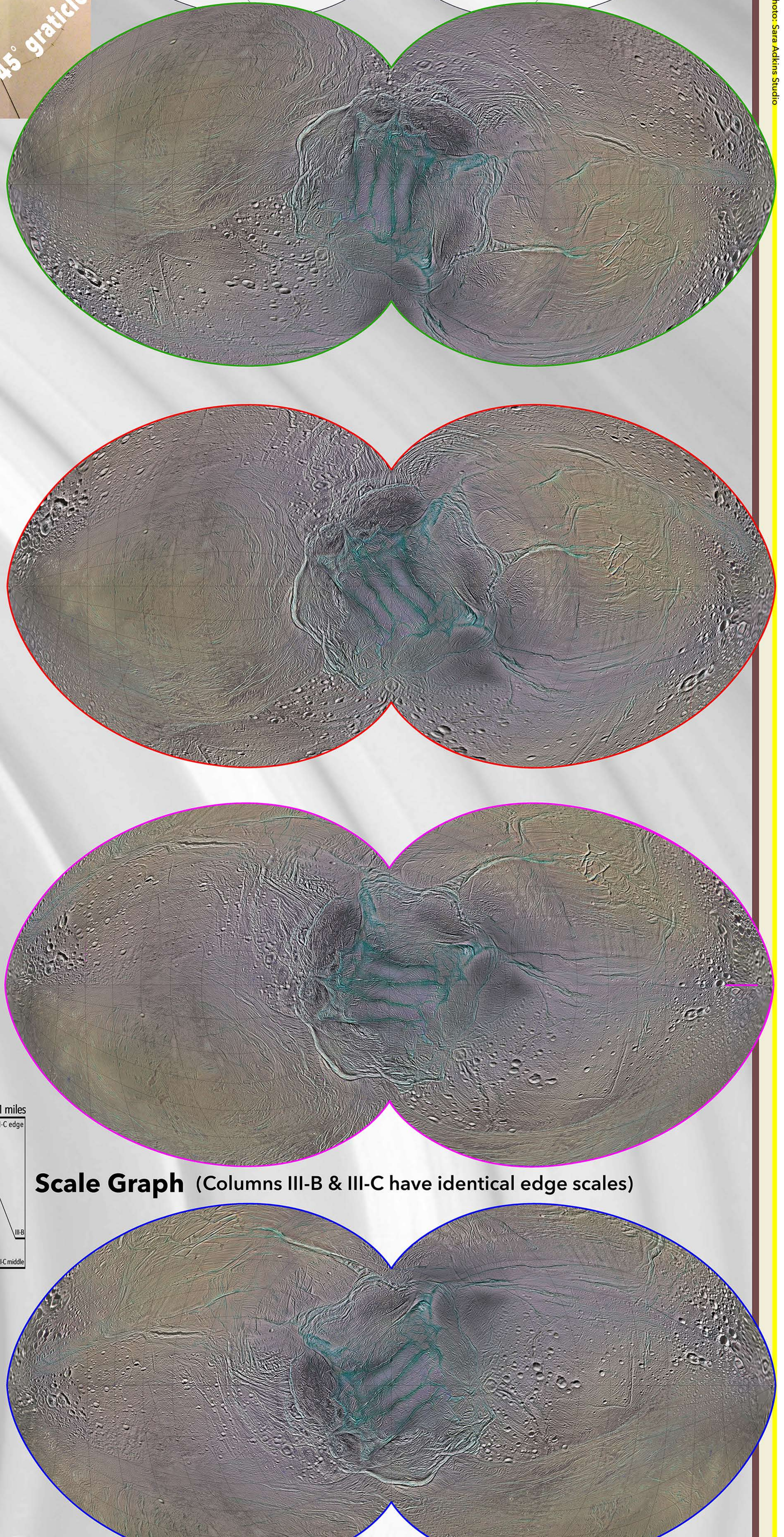


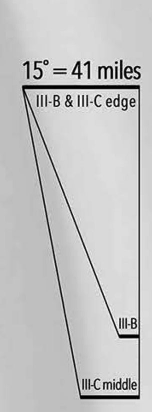
III-C: Pseudo-Eisenlohr Projections (270° cut)

Deepening the cusp of the Eisenlohr while simultaneously preserving constant scale around the perimeter is mathematically quite challenging and likely would result in a definition of a projection that cannot be readily expressed by a finite combination of well-known transcendental functions—Dan Strebe, GEOCART

Ah, then—Geometry does something algebra cannot!







Scale Graph (Columns III-B & III-C have identical edge scales)

Drafting Maquette Photo: Sara Adkins Studio

Photomosaics transformed from PIA18434, NASA/JPL-Caltech/SSI/LPI

WE DISCOVERED THESE maps by, first, deconstructing tidal flexure into component forces and persistent strain regimes. *See sketch, above.* Then, we noted four things:

1) Tiger stripes are 45° to tidal vectors, suggesting that tiger stripes are shear cracks.

2) Poles are dichotic: north is old and stable, while south is young and active.

3) A strain regime inflection zone at 45° latitude limits both polar regions.

4) Maxwell's graphic stress analysis *(top left)* might work on non-Euclidean surfaces via intercession of map projections *(see column III-A)*, of which Eisenlohr's—with its constant-scale edge— immediately suggested itself, in oblique aspect, the cut centered on the quiescent northern pole *(see column III-B)*.

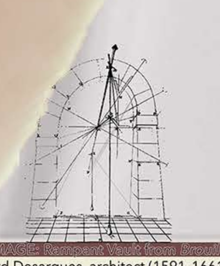
BUT EISENLOHR'S PROJECTION employs a 180° cut. To align our desired cut with the 45°S inflection zone, we need 270°, and the Eisenlohr is difficult—if not impossible—to modify. (*See quote, top right.*)

We therefore handplotted constant-scale natural boundary "pseudo-Eisenlohr" projections *(column III-C)*. These maps, because they show polar regions commensurately with the flanking lobes, have the ancillary visual benefit of putting tiger stripes in global context, relative to the boundary choice *(color-keyed above)*.

Thus, paraphrasing Maxwell *(top left)*, we may "explain, illustrate and extend" the tiger stripe phenomenon with a projection derived from constant-scale natural boundary principles. (That is to say, we composed the map from natural features rather than the other way around, as orthodox projection logic would have it.)

Saturn adapted from PIA01268 An Infrared View of Saturn, NASA/JPL/STScI, 1998

PUTTING ENCELADAN TIGER STRIPES IN GLOBAL CONTEXT



Girard Desargues, architect (1591–1661)

C. S. Clark & P. E. Clark

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Poster & Handouts courtesy: riot creative imaging
Image Wizard: Bill Mills

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Jet Propulsion Laboratory, California Institute of Technology

R625: ***ICY SATELLITE TECTONICS***