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Structural evidence of global expansion on the Ganymede icy satellite

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Grooved terrain consisting of hundreds kilometers-long swaths of parallel, periodically-spaced ridges and troughs of different orientation and shape, characterizes the surface of the Ganymede icy satellite. This terrain constitutes tens-to-hundreds kilometers-wide sulci of light terrain interposed between dark terrain units and results from fragmentation and separation of the dark terrain. Grooved terrains have been often considered as tectonic-related structures within an extensional-dominating regime. Although there is a complete agreement about the primary role of extensional faulting, more debated is the evaluation of the total amount and origin of Ganymede expansion. Evidence for crustal plates drifting and their relative movements have been constrained, in some key areas of the satellite, by the recognition of piercing points such as craters and/or groove lanes that allowed restoring the terrains to a pre-deformed scenario through the closure of the sulci interposed between the dark plates. This kind of interpretation suggests an extensional deformation mostly guided by "Mode I" open fractures along regional-scale spreading centers. In the majority of the observed cases, sulci showing "smoother" terrains constitute spreading centers, where total resurfacing is supposed. In other cases, where later or no break-up occurs, grooves may represent fault systems in incipient or aborted rift, respectively, and the resurfacing could be local along some dike-induced fault planes.
A global expansion model could justify large extension and new crust formation along with the absence of contractional features. We suggest that extension through the development of spreading centers may play a primary role in the tectonic evolution of the globally expanded Ganymede, as hypothesized for other icy satellites such as Europa.