GEOLOGY OF GALILEO REGIO QUADRANGLE, GANYMEDE; James R. Underwood, Jr., Department of Geology, Kansas State University, Manhattan, KS 66502, Ruggero Casacchia, Instituto di Astrofisica Spaziale, Reparto di Planetologia, Viale dell'Universita 11, 00185 Roma, Italia, Alex Woronow, Department of Geosciences. University of Houston-Main Campus, Houston, TX 77204, and Michael J. Teeling, Groundwater Technology, Inc., 80 Holtz Drive, Checktowaga, NY 14225

Galileo Regio quadrangle, including most of Galileo Regio, contains two basic geologic units: older dark, furrowed, and heavily cratered material and younger light, grooved, relatively less-cratered material. Dark material dominates, the light material occurring to the W and SW in about five percent of the quadrangle. Dominant structural features, of uncertain origin, are the NW-trending arcuate furrows and associated orthogonal and oblique furrows in the dark material; grooves in the light material are not as well-ordered nor as intensely developed as elsewhere on Ganymede. Fifteen palimpsests, located partly or totally in the quadrangle and representing the period when the crust became sufficiently strong to record impact events, are subdivided into three relative-age classes, as are the numerous impact craters, some of which are dome, moat, and rampart-like. Galileo Regio is believed to have formed when, because of cooling, differentiation, and expansion, the thin, weak, icy lithosphere broke into blocks and light material filled the space between, or overspread those blocks that subsided, or both. Grooves formed in most of the light material and both light and dark material were cratered by impact, the most recent of which created bright-ray craters, the youngest features visible in the quadrangle.

Introduction: Ganymede has been interpreted to be a mixture of silicate material and water ice, based on its low mean density, 1.94 gm/cm^3, and its reflectance spectra (1); absorption spectra indicate that water ice, together with small amounts of oxidized iron-bearing minerals, constitute most of the surface material (2). Theoretical studies suggest that Ganymede is a differentiated body with a rocky core and a water-ice mantle and lithosphere (3). Voyager I and II spacecraft provided images of Galileo Regio quadrangle that have resolutions between 0.5 and 2.0 km/pixel (4), and the following summary is based on geologic mapping on an airbrush base map (scale c. 1:5,000,000) prepared from those images.

Dark Material: The most conspicuous features of the dark material are the NW-trending arcuate furrows and associated orthogonal and oblique furrows (4,5,6,7,8). Image resolution does not permit the discrimination between an exogenic origin (e.g. impact) or an endogenic origin (e.g. arching owing to an upwelling mantle plume) for the furrows. None of the furrows has craters >10 km superposed, so the furrows must have formed after the lithosphere was brittle enough to fracture but before it was strong enough to preserve larger craters (6). Scattered patches of smooth, dark material occur marginal to such topographic features as furrows and crater rims. The increase in abundance of this material equatorward suggests that the lithosphere may have been thinner there during the emplacement of the smooth, dark material (6).

Light Material: Light material along the western margin of the quadrangle is part of Ur Sulcus, and that along the southern boundary is part of Nippur Sulcus. Boundary grooves, distinct double-walled depressions, separate the dark and light material in most places, and in places the dark material seems to be topographically higher (9). In at least two places in the quadrangle, light material appears to be spreading over dark material as it subsides. Nowhere in the quadrangle do well-developed, complex groove sets and systems, interpreted to have formed from some combination of tensional fracturing and ice volcanism (10, 11, 12, 13), occur as they do elsewhere on Ganymede.

Crater-Palimpsest Material: Palimpsests 100-400 km in diameter occur partly or totally in this quadrangle and are classified into three classes of relative age: ancient, old, and young palimpsest material. Young palimpsests have associated fields of secondary craters and ejecta deposits that are designated pitted palimpsest material. Palimpsests are among the oldest crater forms on Ganymede and postdate the furrows in the dark material.

Crater Material: Craters exhibit a wide range of form that is size related: those of <20 km diameter have central peaks; those 20-40 km in diameter have central pits; those >40 km in diameter have terraces and most have domical floors. Three relative-age classes of craters occur: highly degraded, slightly degraded, and bright. Several chains of secondary craters, a few kilometers to about 100 km long, occur; distinctive crater types are dome, moat, and martian-like rampart craters. Both bright- and dark-ray craters occur in the quadrangle. Numerous craters are polygonal in plan, probably reflecting control by the regional fracture patter.

Geologic History: The earliest events in Ganymede's history, accretion and heavy bombardment, are not represented by surface features. The first recorded event was the formation of dark material or of the material constituting the irregular but subdued surface on which the dark material lie. Cooling of the body eventually strengthened the lithosphere such that it could preserve a record of furrow formation and of meteorite impact >10 km in diameter. Earlier and larger impact events are represented by palimpsests; subsequent and smaller events by the spectrum of craters of varied size and degree of degradation. Following the formation of the dark material and the system of furrows, global expansion accompanying differentiation fractured the lithosphere, allowing the emplacement of light material, possibly by a system of convection cells in the mantle. Subsequently, much of the light material was fractured, probably by extensional stress systems. Young palimpsests formed after the light material; bright-ray craters are the youngest features recognizable on the planet. Surface processes currently active on Ganymede are occasional meteorite impact, mass wasting, and ablation, the result either of ion sputtering or of thermal migration of water, or both.

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