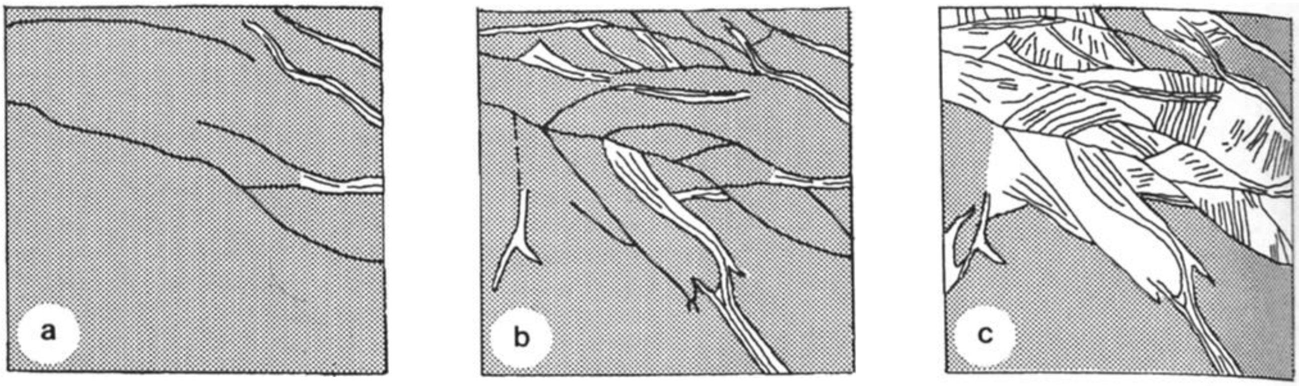

Fig. 2. Three-stage sequence of grooved terrain formation proposed by *Golombek and Allison* [1981]. (a) Formation of primary grooves and bands of grooves. (b) Formation of secondary grooves and groove bands, usually terminating against the primary grooves. (c) Flooding and grooving of intervening polygons.

they approach (3), and are interpreted to be buried by the smooth material. Therefore the grooves marked (1') are interpreted to be older than the grooves marked (3). In Figure 3*f*, several grooves from set (1) continue to the south of and are cross-cut by the younger throughgoing groove marked (2); these southward continuations are marked (1'). Groove (2) also defines the boundary of the older groove set (1). As in the example shown in Figure 3*c*, the throughgoing groove (2) must have been superposed on the fracture zone against which the older groove set (1) did terminate. That initial situation resembled the case shown in Figure 3*d*. Figure 3*g* shows an ambiguous termination relation of groove sets (1) and (1'), in which no clear relative age can be resolved. However, the surface of the smooth band marked (3) clearly is younger than the groove set marked (2), because smooth material has flooded a particularly deep groove in set (2), at the location marked by the arrow. Because the other groove sets terminate at the younger smooth band (3), it must have formed by the reactivation of a fracture zone older than the other groove sets.

Age relations of craters and grooves are determined from the cross-cutting relations of the grooves with crater rims and ejecta. Figure 3*h* shows a crater rim and ejecta superposed on an older groove band oriented west-northwest. The apparent continuations of the grooves across the interior of the crater (shown by the arrows), without the rim being cross-cut, is interpreted to be the result of floor-fracturing that reactivated portions of the grooves. The crater in Figure 3*i* (shown by the arrow) is contemporaneous with the reticulate grooves, because it is partly superposed on and partly cross-cut by the grooves. In Figure 3*j*, all portions of the crater marked by the arrow have been cut by the superposed groove, which clearly is younger.

Although formation of groove sets is closely associated with resurfacing (Figures 3*a*, 3*c*, 3*e*, 3*g*), grooves are observed to cross-cut portions of dark terrain without accompanying emplacement of light material. Where groove sets in the dark terrain are superposed on features of significant topographic relief such as craters (Figure 3*i*), the preexisting topography is structurally degraded but knobby remnants remain. Therefore the identification in light terrain of groove set formation accompanied by resurfacing is based on burial of these remnants of preexisting topography. In Figure 3*k*, the groove band marked (2) is interpreted not to have been resurfaced at the time of its formation, because an older groove set, marked (1), is still visible where (2) is superposed. The groove band marked (2) in Figure 3*l* is interpreted to have been resurfaced, because within it there are no visible remnants of the underlying groove set, marked (1), that is visible around the groove band.

The throughgoing features (2) in Figure 3*c*, (2) in Figure 3*f*, and (3) in Figure 3*g* are younger than the groove sets that terminate against them. This is the reverse of the expected structural T-relationship, which is seen in Figures 3*d* and 3*e*. Therefore the throughgoing features in Figures 3*c*, 3*f*, and 3*g* are interpreted to have been formed by the reactivation of structures, probably grooves, that are older than the groove sets marked (1). This general type of feature, the reactivated zone of weakness, is extremely significant because it implies at least three episodes of deformation: formation of the throughgoing fracture zone, formation of the grooves terminating against the fracture zone, and reactivation of the throughgoing fracture zone to form a band of grooves or a smooth band.

Crater-density Measurements

The validity of the geologically mapped relative age units was tested by measuring the density of craters superposed on each unit. Where necessary to improve counting statistics, temporally adjacent units were combined.

RESULTS

Identification of Terrain Types

The groove domains that intersect in intricate patterns to form grooved terrain are of four morphologic types, which were mapped globally by *Murchie and Head* [1985]. Discussion of properties and interrelationships of these terrain types is drawn from the results of that study. The first of these types is "groove lanes" (Figure 4*a*), elongate bands of parallel grooves, commonly hundreds to thousands of kilometers long. Groove lanes are almost all resurfaced, and commonly taper longitudinally to groove pairs or conspicuous throughgoing grooves [*Shoemaker et al.*, 1982]. Deep, lateral, bounding troughs usually are evident in the narrower groove lanes, and occasional concentration of superposed smooth patches in central portions of the groove lanes suggests central depressions. The spatial pattern of grooves in groove lanes is not unlike that of fractures in terrestrial continental rifts. Models of groove formation, such as that of *Squyres* [1982], also draw an analogy between groove lanes and rifts. This similarity in plan to continental rifts will be examined in more detail in the discussion of implications of tectonic patterns for global processes.