FROSTED QUARTZ SAND GRAINS AND DOLOMITE-QUARTZ OVERGROWTH RELATIONS, LITTLE FALLS DOLOMITE (UPPER CAMBRIAN), EASTERN NEW YORK

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ABSTRACT

The scanning electron microscope was applied to the investigation of "frosting" and dolomite-quartz overgrowth relations in the Late Cambrian Little Falls Dolomite (New York State). Structures and relict grains in the neomorphic dolomite indicate a peritidal to shallow subtidal depositional site. The impressive roundness and good sorting of the abundant quartz sand grains, the lack of associated argillaceous material, and a metastable heavy mineral assemblage strongly suggest a prolonged period of eolian activity.

Frosting is due to an irregular surface consisting mainly of positive, generally "blob-like" features separated by a few micrometers of negative relief. Commonly this microtopography lacks any "orientation" and is attributed to secondary quartz precipitated on the terrigenous quartz grains. Although most of this secondary quartz is later diagenetic, some may have been precipitated syndepositionally by desert dew. Also, on some grains, parallel microridges of precipitated quartz suggest modification of original upturned plates. An interpreted paragenetic sequence of dolomite followed by incipient quartz overgrowths (developing into true euhedral overgrowths) further supports my contention that later diagenetic precipitation of silica is primarily responsible for the frosting.

INTRODUCTION

The Little Falls Dolomite (Upper Cambrian, eastern New York) consists of about 120 meters of associated dolomite, quartzose dolomite, dolomitic sandstone, and quartzarenite. The formation is exposed in a roughly east-west zone of graben and horst structure along the southern margin of the Adirondacks (Fig. 1).

of dolomitic sandstone and quartzarenite ranging in thickness from laminations to, in one instance, a 3-meter thick sequence; generally such intervals are less than a foot or two in thickness. Many of the beds are cross-stratified; the sets commonly possess planar bounding surfaces and include tabular and wedge-shaped units.

The predominant modes of these quartz grains are in the fine and medium sand range. Sorting is good to excellent and roundness of these grains is very pronounced (Fig. 2). These characteristics, coupled with the noticeable lack of associated shales (and clay) and the presence of a limited and metastable heavy mineral assemblage (particularly zircon with more minor rutile and tourmaline) led me to suggest a period of intensive eolian activity for the sand (Zenger, 1979; Zenger, 1981) and a first-cycle origin from the underlying gneisses. Despite my argument for an exposure of these grains to vigorous eolian processes in the absence of land vegetation (see also Selleck, 1979), which could have accounted for the extreme roundness and for the "winnowing" of any clay material, I envision final deposition in a tidally-influenced regime as indicated by the characteristics of the associated carbonates and the presence of a bipolar orientation of cross-stratification (Zenger, 1979; Zenger, 1981).

FROSTED QUARTZ GRAINS

General

A long-held theory for the origin of frosted surfaces on quartz grains was that of impacts in an eolian environment. However, it is now appreciated that frosting can form due to other desert processes or even diagenetically in which case there may be no reflection of the depositional environment (Marzolf, 1976).

Kuenen and Perdok (1962) considered that such frosting of quartz grains in general was due only in minor degree to mechanical action but much more significantly to alternate solution and deposition by desert dew which is capable of penetrating from 2 to 3 centimeters into sand. During an evaporative phase, the dissolved matter will be precipitated in an irregular layer over the entire grain surface as silicic acid or opal. More recently, Folk (1978) has maintained that in the Simpson Desert of Australia, the heavy battering which produces true frosting is *not* occurring and that the "greasy" luster of dune sand grains is due to the precipitation of thin ("turtle-skin") coats of silica developed during very early, extremely shallow-burial diagenesis within sand dunes. He believed that desert dew or sporadic rains could dissolve silica, most likely from siliceous spicules secreted by plants, and on evaporating after seeping into the dunes, these "waters" would be capable of precipitating this silica, probably as opal. Later aging and dehydration would cause the opal to stabilize as microcrystalline unoriented quartz in "scabs" which produce the "turtle-skin" coats.

Some time ago, Walker (1957) pointed out that frosting can result from other, mostly later diagenetic processes such as: pressure solution along contacts between adjacent quartz grains; carbonate replacement of quartz along grain boundaries; differential solution of quartz grain surfaces by percolating groundwater, and; incipient quartz overgrowths.

Frosting on Little Falls Grains

The frosting on Little Falls quartz sand grains appears as a very roughened surface (Fig. 3) somewhat resembling that of some Recent eolian sand grains (Krinsley and Doornkamp, 1973) and proposed ancient analogs (Krinsley and others,