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Cherty ironstone hosted in Eocene marine carbonates: Tectonic and sedimentological controls on iron and silica formation

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In this paper, we focus on the sedimentology and tectonic controls on the formation of cherty ironstone hosted in the Early Eocene Naqb Formation exposed in the northern part of the Bahariya Depression (Egypt). This rock unit (up to 13 m thick) is composed of two carbonate sequences separated by a paleokarstic surface. The Naqb Formation was deposited on a shallow-water platform with intertidal, shallow subtidal and oolitic shoal facies. Dominant organisms in these environments comprise larger benthic foraminifera (nummulites, alveolinids, miliolids, orbitolites), dasycladacean algae, mollusk shells and some echinoids whereas the non-skeletal grains are mostly of ooids, oncoids and pelloids. The two carbonate sequences have undergone extensive diagenetic processes, the most important of which are the karstification, dolomitization, silicification, barite formation and Fe/Mn accumulation.
The Naqb Formation was totally replaced and/or cemented spatially by iron-bearing minerals and/or silica in the vicinity of major faults affected on the area. In the distal parts, the mineralization is only localized along the major sedimentary discontinuities. Outside the faulted areas by 1 to 2 km, the Naqb Formation was not replaced by iron: Even though, pinkish colored dolostones due to pigmentation and staining by iron were observed. The depositional structures (facies and structures) as well as the karstic features (dissolutions, brecciation, etc.) shown by the host carbonates are preserved by the ore deposits. The iron mineral phases, with the associated silica, manganese, barite and others, represent a replacement and open-space filling products (breccias, concretionary and vein-type). Petrographic and mineralogical observation revealed that the two carbonate sequences experienced fabric retentive dolomitization processes that resulted in the formation of unimodal (rarely polimodal), fine to medium-grained, subhedral to euhedral loosely-packed mosaics of dolomite. Later, the carbonates were silicified and ferruginized where the iron oxides and/or silica occur as pseudomorphs after dolomite crystals. The silica occurred mainly in the dissolved clasts and other associated diagenetic features (e.g., dissolution tubes) as well as in sedimentary discontinuities. Silica occurs mainly as mega-quartz, micro-quartz and chalcedony quartz and sometimes shows banded fabrics alternating with the dolomite and iron bands and laminae. Different textures of iron oxides (e.g., massive amorphous, boxwork brecciated, colloform and alveolar cavity-filling textures) were formed after silicification. In addition, the oolitic and oncolithic fossiliferous as well as the laminated textures of their host carbonate facies were preserved and replaced by iron oxides with relics of dolomites.
According to these features, a new sedimentary and diagenetic model is provided to elucidate the genetic mechanisms for the cherty ironstone hosted in carbonate sediments in the Bahariya area. The ironstone deposits are interpreted as a replacement product formed by dissolution of specialized host rocks (dolomites) and concomitant generation of dolomite pseudomorphs followed by precipitation of iron minerals through structural traps (faults). The formation of these deposits resulted from abundant crustal silica and iron-rich fluids leached from the underlying basement rocks under acidic conditions. This explanation for the formation of cherty ironstone of the Bahariya region is similar to that provided by some previous genetic models for banded iron formation (BIF).