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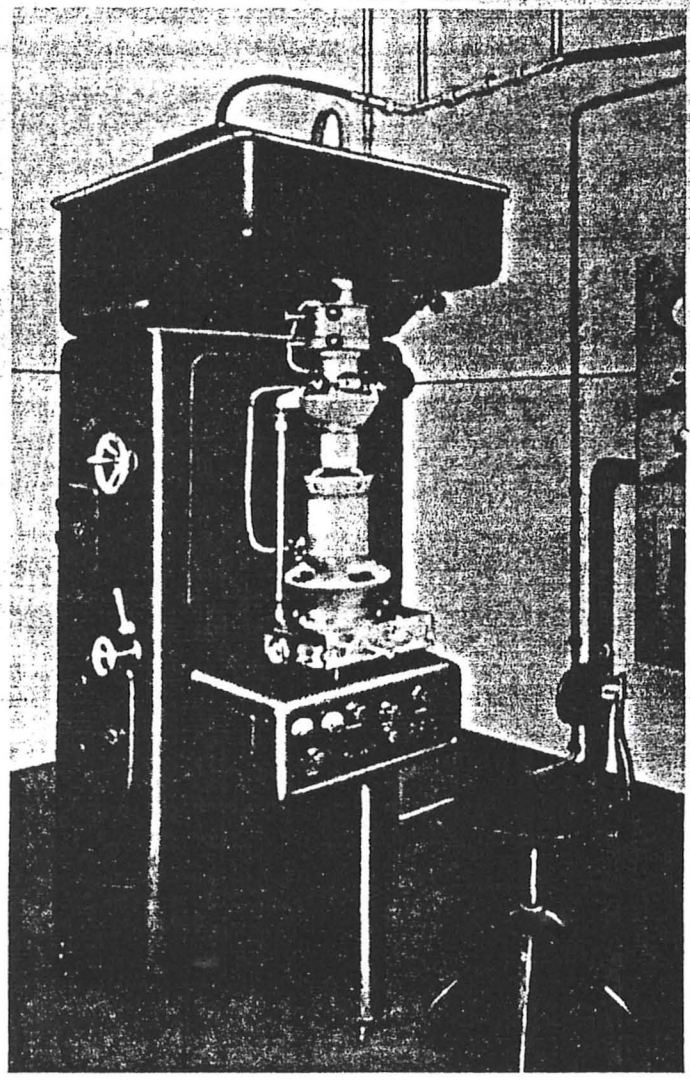

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FRINGED CRYPTOMELANE/HOLLANDITE IN THE VILA VELHA SANDSTONE TELOGENESIS

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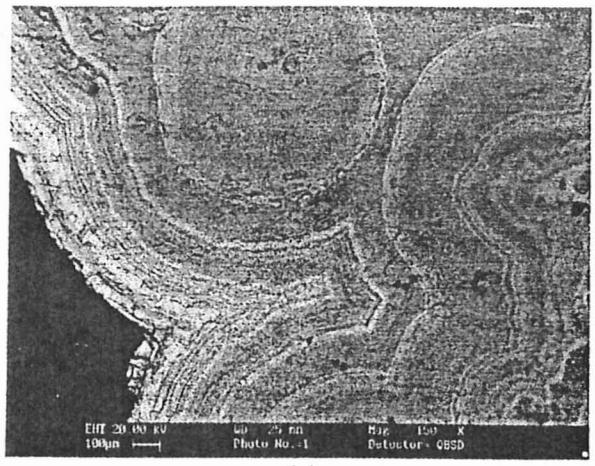
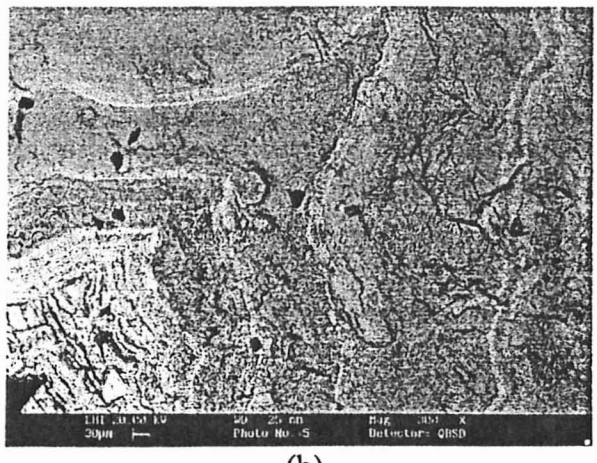
The Vila Velha Sandstone (Upper Carboniferous of the Paraná Basin) is a reddish quartzous sandstone that forms a remarkable group of natural sculptures in the top of eroded inselbergs in the Vila Velha State Park, situated about 80 km WNW from Curitiba, Paraná State, Southern Brazil. The sandstone sculptures are the result of many interacting factors, such as the variable attributes of the sedimentary rock, tectonic and non-tectonic fractures, physical, chemical and biological weathering. Three main trends of vertical fractures (NE-SW, NW-SE and E-W) of Mesozoic age are important brittle structures of the area, related to the Gondwana breakup and the South Atlantic opening. These structures closely control the cementing of the sandstones by iron and manganese oxides and the shape of sculptures. The distribution of cementing zones forms a pseudostratification parallel to the fractures and discordant to the sedimentary structures. Both iron and manganese cementing are seen as telogenetic processes controlled by the presence of pseudomatrix (crushed muddy lithic fragments) and the fractures. Geomorphological and paleoclimatic evidence suggests that cementing processes at Vila Velha took place during important laterization phase in Southern Brazil in the Pliocene-Pleistocene limit. The ferriferous cementing makes the sandstone reddish and can form duricrusts. The manganese oxides form continuous metallic veins only a few centimeters thick which fill the NE-SW and E-W fractures. The sandstone in the walls of these veins shows several botryoidal fringes formed by cementing, each one about 1 cm thick. The X-ray diffractograms of the massive metallic oxides revealed the pattern of cryptomelane-hollandite group. The thin sections and back-scattered SEM images of these oxides (Figure 1) show alternate dark and bright fringes 10 to 100 μm thick. The EDS analysis (Figures 2 and 3) shows different rates of O (63-66%), Mn (30-33%), K (1-4%), Ba (1-3%) and some Na and Al (less than 1%). The dark fringes are enriched in K while the bright fringes are enriched in Ba. Based on the X-ray diffractograms and EDS results, the mineral in the dark fringes is cryptomelane (KMn_8O_{16}), while in the bright fringes the substitution of the K by the Ba gives rise to the mineral hollandite ($BaMn_8O_{16}$). The recognition of two different mineralogical phases was only possible by SEM-EDS, due to the impossibility of differentiation between two isostructural phases by X-ray diffractometry technique.



(a)



(b)

Figure 1: Fringed manganese oxides (dark cryptomelane and bright hollandite) in botryoidal metallic veins from the Vila Velha Sandstone

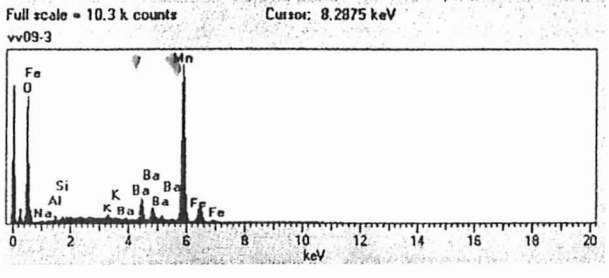


Figure 2: EDS of the bright fringe on Figure 1 (a and b)

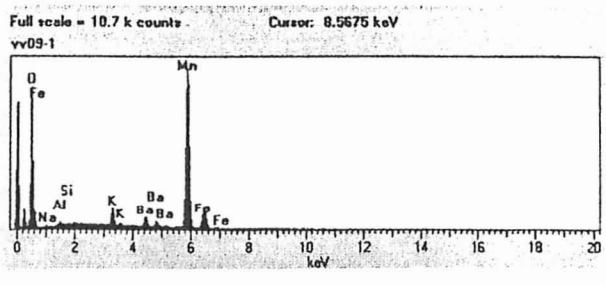


Figure 3: EDS of the dark fringe on Figure 1 (a and b)