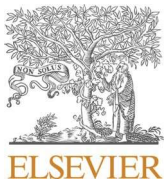
Sedimentary Geology 482 (2025) 106885



Contents lists available at ScienceDirect

Sedimentary Geology

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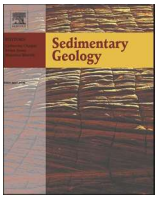

Depositional environment and redox conditions of the Moncorvo Ironstone – Unveiling the evolution of ironstones under Rheic Ocean influence

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ARTICLE INFO

Editor: Dr. Massimo Moretti

Keywords:
Ironstone
Moncorvo
Ordovician
Rheic Ocean
Ooids
Paleoredox conditions
Crandallite
Apatite
Chamosite
Iron oxides

ABSTRACT

Ironstones, as key archives of past marine environments, provide invaluable insights into Paleozoic history. Their mineralogy may reflect the physical-chemical conditions of the environment and the nature of available sediments. This study focuses on the Moncorvo Ironstone, a Lower-Middle Ordovician deposit formed during the opening of the Rheic Ocean. Here, we use an integrated approach combining sedimentology, petrology, and geochemistry to constrain the depositional settings and the redox landscape associated with the ironstone deposition. The Moncorvo Ironstone present some unusual characteristics, such as the lack of ooids, an uncommon mineralogy, and a stratigraphic thickness that can reach over >45 m, a remarkable feature for an ironstone. Our investigation reveals that this iron-rich sequence is distributed in two distinct marine environments: an inner shelf and a middle to distal shelf. Each environment has a unique mineral assemblage. Despite the influence of metamorphism and deformation, evidence suggests that much of the mineralogy and texture of this deposit still preserve characteristics of the original sediments. Finally, our findings, alongside a careful assessment of the mineralogy of other ironstones of similar age, suggest a strong stratification of the Rheic Ocean throughout the Early and Middle Ordovician.

1. Introduction

The origin of iron-rich sedimentary rocks is influenced by a myriad of biogeochemical and paleoenvironmental features including redox conditions, depositional settings, and biological activity (Young, 1989; Petranek and Van Houten, 1997; Bekker et al., 2010; Pufahl and Hiatt, 2012). These rocks are classified in two groups according to their sedimentary structures, mineralogy and stratigraphic sequence: ironstones and iron formations (IFs) (Bekker et al., 2010; Pufahl and Hiatt, 2012). Usually of marine origin, ironstones are, chert poor, phosphate rich, occur in association with siliciclastic or carbonate-siliciclastic rich strata and, in general, Phanerozoic (Young, 1989; Petranek and Van Houten, 1997; Lechte et al., 2024). The most striking feature of these ironstones are the coated grains (ooids) enveloped by Fe-bearing minerals and phosphates (Young, 1989; Petranek and Van Houten, 1997; Matherson and Pufahl, 2021; Matherson et al., 2022).

In contrast to the IFs, ironstones have received far less attention in scientific literature. However, in the last 5 years, ironstones have gained the attention of researchers due to its potential to provide clues on the oxygenation of the atmosphere-ocean system and its relationship with biological processes during the Phanerozoic (e.g. Todd et al., 2019; Rudmin et al., 2019; Pufahl et al., 2020; Dunn et al., 2021; Matherson and Pufahl, 2021; Matherson et al., 2022; Vodrážková et al., 2022; Lechte et al., 2024). For instance, recent studies suggest that the oxygenation of the atmosphere-ocean system during early Paleozoic was a heterogeneous process, punctuated by minor extinction events, biodiversification events, and changes in the paleo-oceanographic patterns (Edwards et al., 2017; Pufahl et al., 2020; Cocks and Torsvik, 2021; Matherson et al., 2022).

In this context, the study of the Ordovician ironstones formed under

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https://doi.org/10.1016/j.sedgeo.2025.106885
Received 28 January 2025; Received in revised form 22 April 2025; Accepted 23 April 2025
Available online 30 April 2025