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## Case study

# Provenance investigation of white marbles of chancel screens from Rihab Byzantine churches, northeast Jordan

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## ABSTRACT

This research investigates marble trade and supply to north Jordan during the Byzantine period. The Archaeological site of Rihab is famous for its wealth of churches renowned for their mosaics and marble. Twenty-one samples of decorated marble used in building the chancel screens of four churches were selected for scientific analyses to determine their provenance. In addition to the Electron Paramagnetic Resonance (EPR) the main discriminating technique, oxygen and carbon stable isotopes and maximum grain size were measured and compared to the databases of ancient quarries from the Mediterranean region. The results showed that the most probable source of most of the samples is Proconnesos (Marmara, Turkey), while only two samples exhibit clearly different properties and have been identified as Docimium (Afyon, Turkey) marble. The results also indicated that the Marmara Island remained a major center of marble trade to this region during the Byzantine times probably because of its good quality and low cost.

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## 1. Introduction

Rihab is a small town, located in the Mafraq Governorate, north-east Jordan, and about 26 km from the Jordan-Syrian border and 40 km south of Bostra (Fig. 1). Rihab has aroused considerable interest because of its wealth of inscriptions and churches. The first discovery of inscriptions occurred in 1900 by Schumacher who discovered two Greek inscriptions [1], while the first discovery of churches was in 1932 by Alt [2]. The first known archaeological excavations at Rihab were conducted by Hardening during 1936–1942 [3], while Lux and Mittmann in 1958 discovered a church dedicated to St. Mena which was built in AD 634 [4,5]. In 1979, two other churches were excavated by Piccirillo [2]. Thereafter, excavations were conducted by the Department of Antiquities and supervised by Al-Housan since 1991, and so far 30 churches have been discovered. The pavements of the churches were adorned with mosaics, while most of their chancel screens were built of decorated white marble [3,6] (Fig. 2). The marble posts and panels, most likely, were intentionally decorated to be used for the chancel screens. Because there is a little data about the marble trade during the Byzantine period in this region [7], the determination of the provenance of the marble will increase our knowledge

about ancient marble extraction, architectural working and trade organizations.

It is now well accepted that no single technique can provide reliable determinations and resolve all problems related to marble sources because overlapping results within and between different sample regions occur [8]. Several scientific techniques were utilized to determine the provenance of ancient marbles; see, for example, [9–16]. EPR spectroscopy, associated with one or more other techniques including oxygen and carbon stable isotopes ( $\delta^{13}\text{C}$ ,  $\delta^{18}\text{O}$ ) and maximum grain size (MGS), color, petrography, etc., has become a well-established technique for marble provenancing [17,18]. The EPR technique measures the concentration of manganese ions ( $\text{Mn}^{2+}$ ) commonly present as an impurity in marbles and exhibits its spectra type and intensity which take into account other paramagnetic impurities; for more details, see [19–21]. This research uses the EPR as the main technique, and  $\delta^{13}\text{C}$ ,  $\delta^{18}\text{O}$ , MGS and color, to determine the source of marble samples collected from four chancel screens of Rihab churches.

## 2. Materials

Excluding sample 2, a beige marble plate, which was associated with the chancel screen marbles of Saint Procopius, 20 marble samples were collected from the chancel screens of four churches located in Rihab (1–6 from Saint Procopius, 7–13 from Saint Procopius, 14–18 from Saint John the Baptist, and 19–21 from Saint

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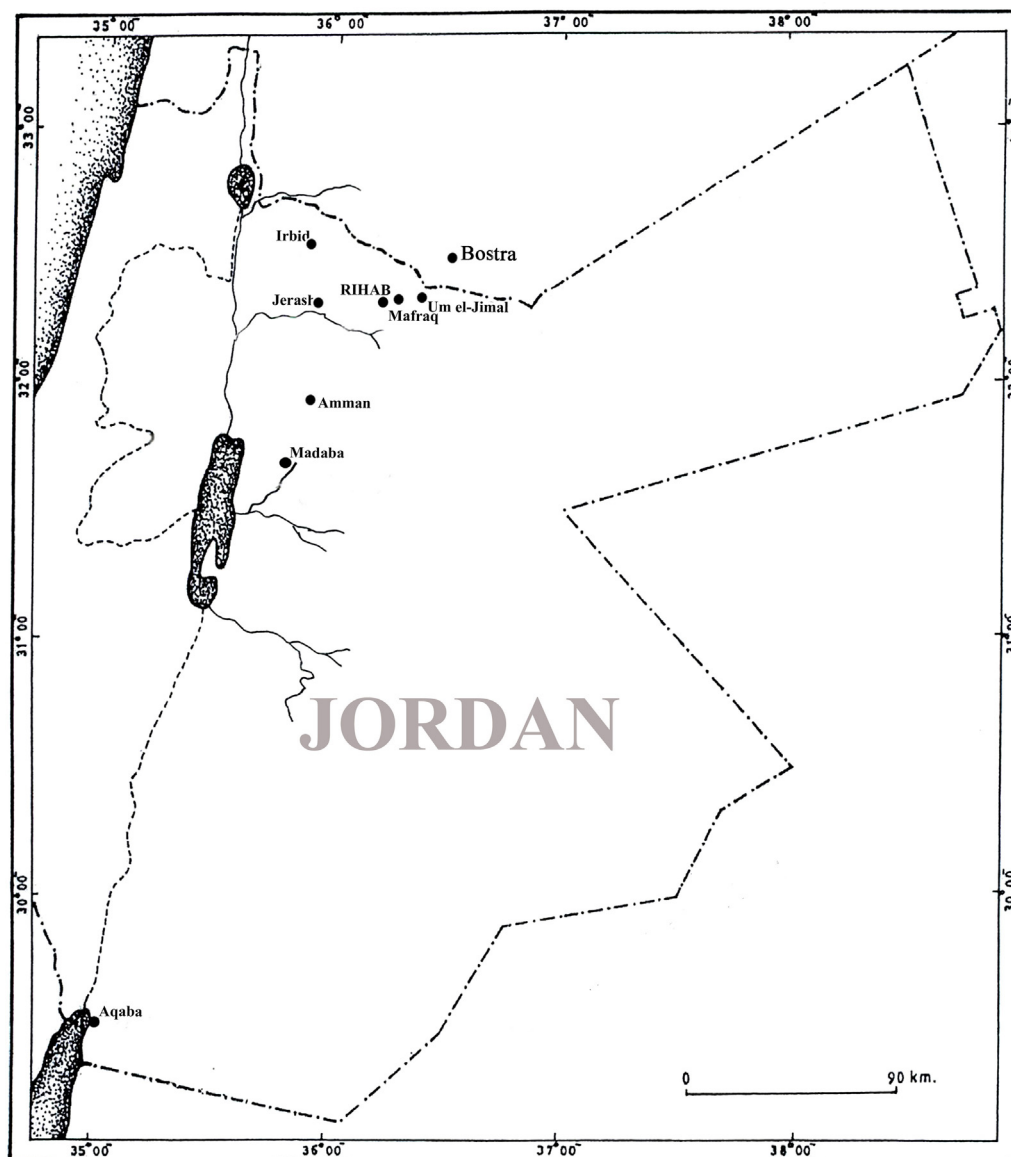


Fig. 1. Geographic locations of Rihab and other neighboring archaeological sites.

George) (Fig. 2). The chancel screens are of carved marble panels inserted between marble posts and were uncovered during the excavations of the past two decades. 11 posts (cylindrical 5, 9, 10, 12, 16, 17, 20 and square 5, 14, 15, 19, 21), 8 panels (1, 3, 4, 7, 8, 11, 13, 18) and 1 joist (6) were selected for sampling. While samples 14, 15, 16, 17 and 18 were collected from *in situ* panels and posts of John the Baptist (Fig. 2), the rest of the samples were collected from broken panels and posts stored at the storage of the Department of Antiquities of al-Mafraq.

Chancel screens are architectural and liturgical elements of standard dimensions and uniform style that emphasized the limits of the ritual area. All the elements of a chancel screen were precisely produced in finished or semi-finished states at the workshop of the quarry, shipped to their final destination where they were firmly connected and fixed in place. A large number of parallels to the studied samples were reported in [22]. Different reasonable grounds indicate that Rihab marbles were not reused. The posts, panels and other elements of this study were uniform and do not show signs of reuse. These standard elements of limited uniform styles indicate that their production and distribution was restricted

to certain workshops and managed by an active (imperial or religious) authority; see [23] for more details. In addition, uncovered shipwrecks [24,25] and field surveys at Proconnesos quarries [26] reported the presence of a large number of similar marble elements prepared and/or shipped to churches. Furthermore, stylistic analysis of marble chancel screens from Palaestina and Arabia (including Jordan) by Habas [23] concluded that most of them were imported.

### 2.1. Procopius church

This church is located to the south of and adjacent to the John the Baptist church within the religious complex of Rihab. The 2002–2011 excavations showed that the church is a basilica (32 × 18 m) of a nave and two aisles separated by columns' bases that still exist. According to a dedication written in the mosaics in front of the chancel, it was constructed in the mosaics in front of the chancel, it was constructed in AD 594. It is believed that the basilica was built on remnants of a Roman temple, whereas the rooms and apse were modified for housing during Mamluk and Ayyubid periods according to the uncovered Mamluk and Ayyubid coins and

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