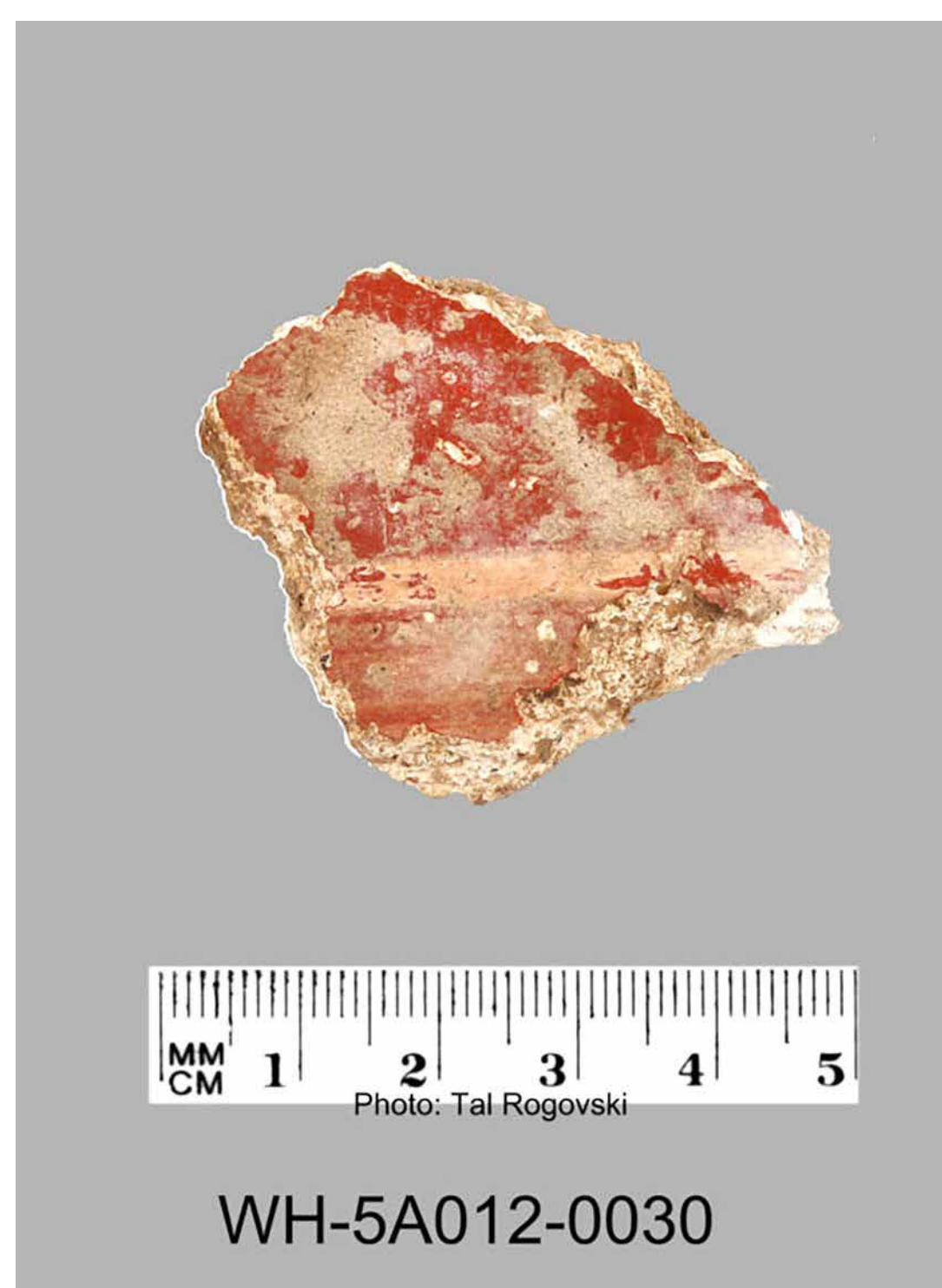


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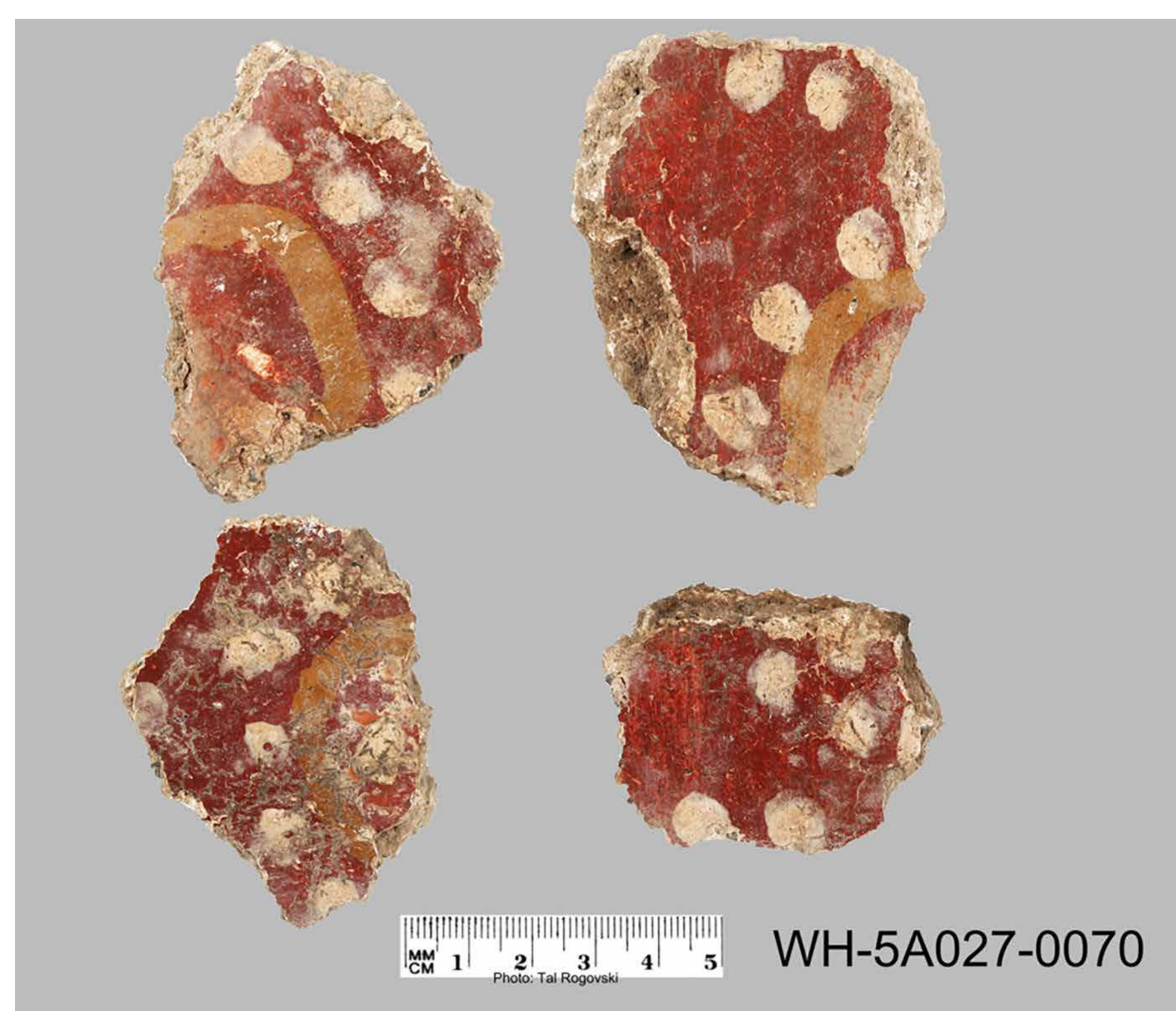
## Fragment Analysis from Khirbet Wadi Ḥamam (Lower Galilee)



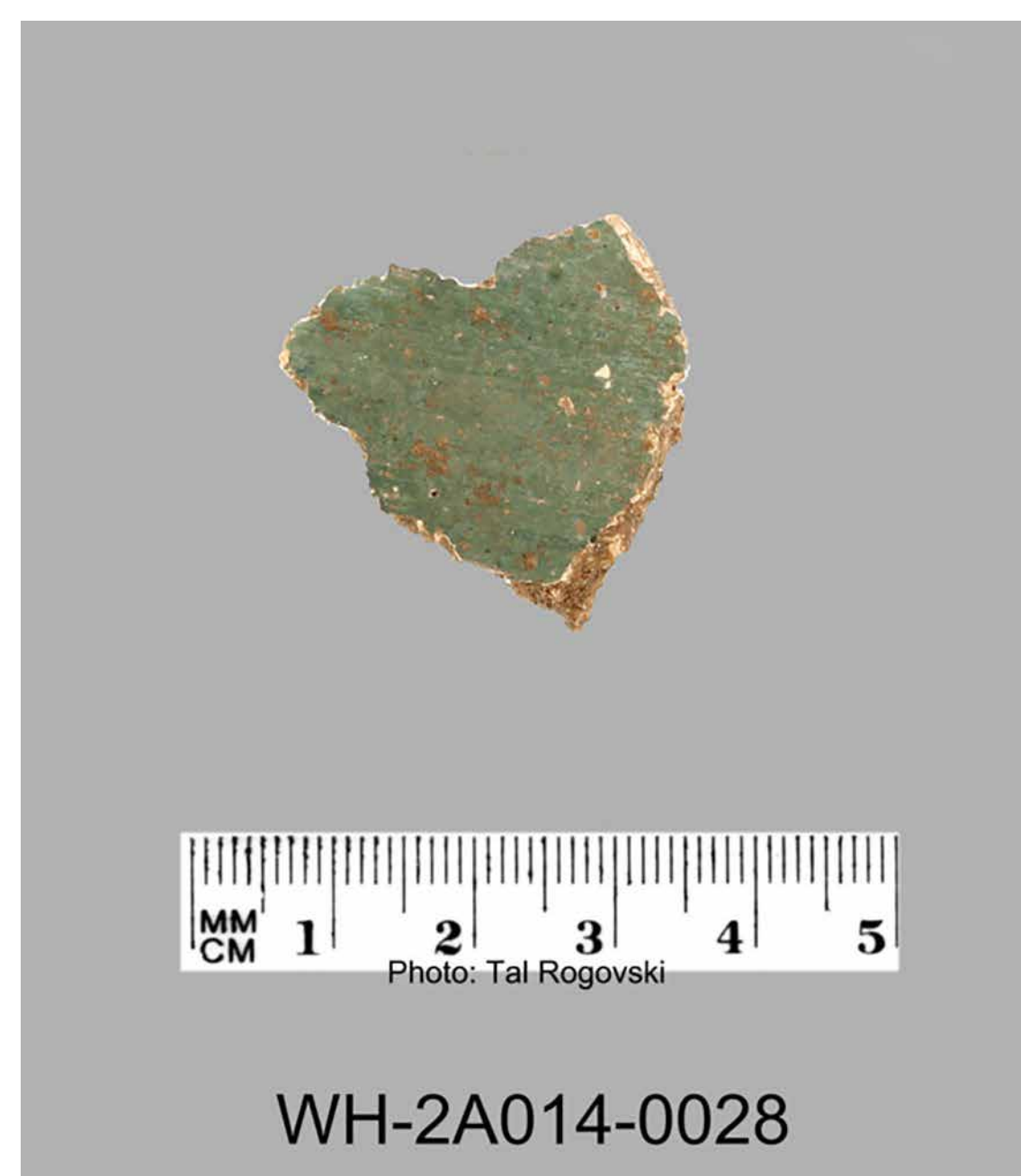
1. Red and yellow ochre fragment with white stripe from Stratum 3 (A8/L/4A040).



2. Dark red fragment with yellow-cream line from Stratum 3 (A5/L5A012).



3. Dot design fragments, with yellow stripes and white spots on dark red background from Stratum 2 (A11/L5A027).



4. Green fragment from Stratum 3 (A1/L2A014).



5. Orange fragment from Stratum 2 (A11/L5A021).

Fragments of wall paintings found in the Khirbet Wadi Ḥamam synagogue excavations were painted using a *secco* technique with colors ground in water. In many fragments, the surface was quite rough and brush strokes were prominent. These indicate the use of brushes of varying thickness, although their specific sizes and materials remain unknown.

The material was stratigraphically related to two layers: Stratum 2 (ca. 200-400 CE), and Stratum 3 (end 1<sup>st</sup> century BCE-beg. of 2<sup>nd</sup> century CE). Comprehensive analyses conducted on the fragments, together with the observation of technical traces, reveal some differences but also many similarities, in terms of both materials and painting techniques, in spite of the different centuries of their creation.

Colors and plaster were analyzed with non-destructive techniques of X-Ray diffraction (XRD) and scanning electron microscopy (SEM) equipped with energy dispersive X-ray spectroscopy (EDS). The samples (analyzed to identify pigments, estimate their content and crystallite size, their elemental composition and the type of plaster) made it possible the mineralogical identification of the pigments and the plaster materials. Accordingly, the fragments can be divided into two groups based on their quality and ingredients.

The earlier Stratum 3 fragments display a plaster preparation of comparatively high quality, composed of two relatively thick layers of coarse plaster. The gray, base layer (2-3 cm) is made of lime plaster containing ash and grits. The upper white layer (on which the paint was applied) is thinner (0.4-1.0 cm) and denser, composed of lime plaster containing smaller grits, and has a porous consistency and a finer finish. The technique is less elaborate than that recommended by Vitruvius, as well as that in Herodian local wall paintings, indicating good knowledge of the basic process but a less sophisticated technique, typical of the 1<sup>st</sup> century CE. The colors identified in the Stratum 3 fragments are white, yellow-ochre, and various tonalities of red, green, and black.

Wall-painting fragments from Stratum 2 are characterized by a plaster preparation of lower quality. Most of the fragments, painted in white, yellow-ochre, and various tonalities of red, orange, green and black, were painted on a coarse plaster with large aggregates, usually composed of only one layer (1-4.5 cm) with a smoothed surface for the application of the *secco* painted layer.

Color analysis confirmed that, generally, the pigments' composition was similar in both strata. White, was composed of the carbonate mineral calcite, common in various regions of Israel. Yellow-ochre, was composed of yellow earth. Red, prepared from hematite, was one of the most common colors on fragments from both layers. It appears in various tonalities, from simple or pale red, to a darker red and purple-red. The hematite pigment (*rubrica*), is a natural earth pigment occurring in the Negev in Israel, and in the Gilead region. The differences in tone are a result of the percentage of pigment used in the preparation of the paint, e.g. 5.8% of hematite for simple red, 8.4% for dark red, and 12.7% for purple-red. Green, an earth pigment (*terra verde*) containing celadonite, appears only in a few fragments from the synagogue area in both strata and as lumps of pigment, in Stratum 2. According to Vitruvius, *creta viridis*, the green earth pigment containing glauconite or celadonite, was found in many places in the Roman world. However, as celadonite does not occur in Israel, it may have been imported into Israel from Cyprus or Italy. Black was made from charcoal (probably burnt wood).

Despite the fact that the sampled fragments belong to different periods, the pigment's palette was quite similar. However, the range of colors in the fragments from Stratum 2 differs from that in the earlier fragments. Some of the background colors are duller, others are especially strong. Similar hues are known from 2<sup>nd</sup> and 3<sup>rd</sup>-century strata in excavations throughout the Country, e.g. the fragments from Naḥal Refa'im.

In addition, a new color, orange, appears. This is a rare color, created from the minium pigment (also known as red lead). The term minium refers to both the pigment made from ground cinnabar and to the less expensive red lead. The color in the Wadi Ḥamam fragments was made of the less-expensive red lead, which is brighter and was sometimes used in Roman times for orange and bright red. Orange, was a rare color in Hellenistic and Herodian examples, nevertheless it appears on the *in situ* walls at the Royal Room at Herodium, where it is painted in *fresco*, with a brighter and higher quality. The closest similar hue to the Wadi Ḥamam color appears in examples from the end 2<sup>nd</sup>-beg. 3<sup>rd</sup> century CE at Sepphoris.

The dullness of the hues and the careless work, are typical of wall paintings from the late 2<sup>nd</sup>-early 3<sup>rd</sup> centuries CE in Israel, as at Sepphoris, the early synagogue at Ḥamath Tiberias, and Naḥal Refa'im.

In conclusion, in both periods the artist's palette was quite similar, most of the colors were of local origin, and only a few, as green and orange, were imported. Nevertheless, the different plaster techniques and color hues (supported by stylistic comparisons) allow us to identify the product of different periods of production.

I am grateful to Uzi Libner, the excavator, for the permission to study and publish the fragments. For references and a full bibliography, see Rozenberg 2018. Thanks are due to Inna Popov and Vladimir Uvarov from The Center for Nanoscience and Nanotechnology, The Hebrew University of Jerusalem, for their help in identifying the techniques of work and the pigment compositions.

Rozenberg S., *Wall Paintings, Stucco and Opus Sectile Fragments from Wadi Hamam*, in Leibner, U. (ed.), *Khirbet Wadi Hamam. A Roman Period Village and Synagogue in the Lower Galilee*, (Qedem Reports 13), 2018, 593-604.