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A pan-European art trade in the Late Middle Ages: Isotopic evidence on the Master of Rimini enigma

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1 **Abstract**

2 The identity of artists and localisation of workshops are rarely known with certainty before the
3 mid-15th century. We investigated the material used by one of the most prolific and enigmatic
4 medieval sculptors, the Master of Rimini, active around 1420-40. The isotope fingerprints (Sr, S
5 and O) of a representative corpus of masterpieces but also minor artworks, attributed to the Master
6 of Rimini and his workshop, are virtually identical, demonstrating the unity of the corpus and a
7 material reality behind the stylistic and iconographic ascriptions. The material used is exclusively
8 Franconian alabaster, 600 km distant from the supposed zone of activity of the Rimini workshop
9 according to recent literature. The same material was later used by the prominent Late Medieval
10 German carver Tilman Riemenschneider, active in Würzburg after 1483, whose rare alabaster
11 sculptures we were able to characterise almost in their entirety. This leads us to an alternative to
12 the prevailing hypothesis of a Flemish or N-French workshop, founded on similarities of the Rimini
13 sculpture with motives in Flemish and French painting. Our scenario, returning to the initial
14 proposal of a German localisation of the Rimini production, assumes the migration of an artist,
15 perhaps trained in the Low Countries or strongly inspired by the Flemish art, to Southern Germany
16 where he founded a highly productive export workshop, well situated on the crossroads of medieval
17 trade, with a pan-European radiance. This study sheds a spotlight on the on the trade networks of
18 luxury goods and the high-end art market in Europe as well as on international migration of artists
19 and styles, at the eve of the Renaissance.

20 **Introduction**

21 The identity and location of the workshop of the enigmatic Master of the Rimini altarpiece, active
22 around 1420-40, remain unknown, in spite of an abundant production and Europe-wide
23 exportation [1, 2] of his sculptures, exclusively cut in alabaster.

24 The masterpiece of the “exceptionally skilled” [1] sculptor, commonly known as the Master of
25 Rimini, is a crucifixion group including twelve apostles, originally placed in the church of Santa
26 Maria delle Grazie, near Rimini, Italy. It was acquired by the Liebieghaus Museum (Frankfurt,
27 Germany) in 1913 [3, 4]. Distinctive stylistic features of this group led to numerous attributions of
28 alabaster artwork, spread all over Europe, to his workshop. The quality of the Rimini altarpiece
29 and several other stylistically and materially closely related sculptures reached an artistic level
30 designating them to the high-end art market at this time. The few known or supposed clients are
31 princely families like the Italian Borromei and Malatestas [1] and rich abbeys, from Arras to
32 Wrocław. At the other end of this large spectrum, numerous minor works exist, showing
33 similarities with the Rimini masterpieces, workshop productions that may have been destined to
34 the anonymous art market and to personal devotion.

35 The “Master of Rimini” remains mysterious in several respects: Can the artwork from the “Rimini
36 group” be attributed to the same hand, the same workshop or even a group of workshops and
37 stylistic followers? Can the Master be qualified as itinerant or migratory artist with or without a
38 stable workshop? If a stable workshop existed, where was the production located and where was
39 the nodal point of this pan-European trade network?

40 Only a rough estimate of the surviving work is possible due to the diversity within this group
41 hindering a clear definition of the limits of the workshop and possible followers [5]. The broad
42 diffusion (Fig. 1) making a geographic localisation of the workshop impossible, it is again on a
43 stylistic basis that the Master of Rimini was first qualified as typically Middle Rhenish, south of
44 Cologne, notably by Swarzenski [3] who purchased the Rimini group for Frankfurt and initiated
45 the scientific research on medieval alabaster sculpture outside England. He already mentions a
46 second hypothesis of a Netherlandish-French origin of the sculpture of the Rimini group, first
47 formulated by Volbach [6], that is now prevailing, even though, as Kim Woods states in her

48 landmark monography on medieval alabaster sculpture, the possibility that he was German has
49 never been dismissed [2, 5, 7]. Arguments of the proponents of a Flemish origin [1, 2, 4, 8-11] are,
50 on the one hand, the iconographic proximity to paintings by Rogier van der Weyden and the Master
51 of Flémalle and to the painted representation of monochromatic sculptures and other elements of
52 Jan van Eyck's Gent altarpiece [1, 2, 4], and, on the other hand, the fact that the Netherlands, much
53 like Burgundy and England, were exporting gothic art at large scale [6]. Recently, parallels with a
54 14th century French silk painting have been pointed out [12]. Undeniably, the Rimini style is
55 multifaceted and other artistic influences, notably from Central Europe have been discerned [7,
56 13].

57

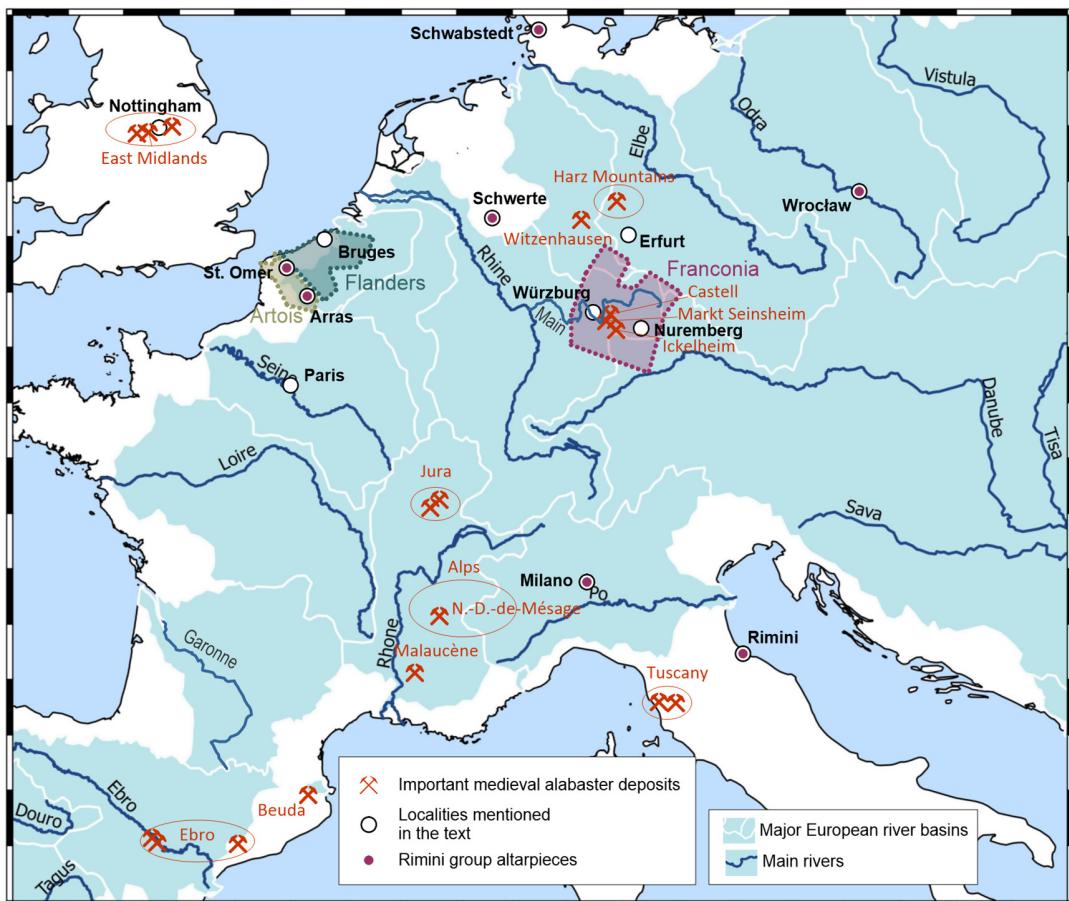


Fig. 1 Potential localisations and export destinations of the Rimini workshop. Major historical alabaster-producing regions in late medieval W Europe and newly investigated deposits in Franconia, historical localisation of the main known sculptural ensembles related to the Rimini workshop (Arras: attribution uncertain), localities mentioned in the text, historical provinces and potential areas of activity of the Master of Rimini (Franconia, Flanders, and Artois in their 15th-early 16th cent. limits). Background map: Major European river basins in light blue, rivers in blue.

Our study sheds a new light on the Rimini enigma, from an angle so far underexploited in a research dominated by art historical, stylistic and iconographic approaches. It focuses on the material used for the artworks attributed to the Rimini group. It was Kim Woods who first stated similarities in

70 the appearance (“similar, albeit not identical” [1]) of the alabaster used both by the Rimini Master
71 and another sculptor and wood carver, Tilman Riemenschneider (1450-1531). He is among the
72 most prominent names of late medieval sculpture and his biography and artistic production, half a
73 century after the obscure Rimini Master, are documented in detail [7, 14]. Both used an alabaster
74 described as “covered with distinctive network of grey veins around 2 mm thick and resembling
75 blood vessels” [1] (Fig. 3A). We make use of the proven capacity of Sr, S and O isotope
76 fingerprints to discriminate historical European alabaster deposits [15, 16] to verify this intriguing
77 resemblance, to test the provenance of the material used by Tilman Riemenschneider, and,
78 ultimately, to provide new evidence to the identity of the Rimini Master and the situation of his
79 workshop by identifying his supply chains. We then confront our geochemical results with the rare
80 written medieval sources on artwork of the Rimini group that we have investigated in some more
81 detail, going back to some of the original manuscripts.

82 Two contemporaneous sources exist that reveal a Europe-wide trade of alabaster sculpture in the
83 first half of the 15th century, the time the Rimini-workshop was active. The first concerns a group
84 representing the swooning Mary, the so-called “Three Maries”, now in the National Museum of
85 Warsaw and investigated in our study (**Fig. 2C**). It was part of a Crucifixion acquired in 1431 for
86 the church of our Lady of the Sand in Wrocław (Poland) by the Abbot Jodocus of the Wrocław
87 Augustinian friary from a Parisian merchant [3, 9, 10, 17, 18], even if Woods [1] points out that
88 the term for designing Paris in the Wrocław trade record (*parysiis in montanis*) is ambiguous. We
89 resolve this ambiguity by identifying the expression “*in montanis*” as a later transcription error that
90 should read “*cum montanis*” as in the earliest preserved copy of Jodocus’ lost manuscript, pointing
91 to a Calvary-like arrangement (see detailed discussion on this point in the supplementary material,
92 Appendix S1 and Fig. S1).

93 The second documented acquisition, one year later, in 1432, was made by Jean de Clercq, the
94 Abbot of the Saint Vaast Abbey at Arras (N-France, Fig. 1), who bought an alabaster Coronation
95 of the Virgin group including the twelve apostles, from a German merchant [19-21]. This ensemble
96 is lost but contemporary alabaster artwork is still conserved in the same ancient Artois region,
97 notably the four apostles (**Fig. 2L-M**), supposedly part of a similar altarpiece with twelve apostles,
98 acquired in 1429 by the canon Gauthier Ponche for the Saint-Omer Cathedral [19], now in the
99 Musée de l'Hôtel Sandelin in Saint-Omer, that can be counted in the group of Rimini art [19]. Both
100 written sources have been used as arguments for situating the workshop in Paris [4, 12], N-France
101 or S-Netherlands [1] or in Germany [22, 23].

102 Whereas the Master of Rimini and his workshop exclusively used alabaster, this material is an
103 exception in the works of Tilman Riemenschneider, one of the most accomplished artists of Late
104 Gothic sculpture. After uncertain years of apprenticeship and journeying, he settled down definitely
105 in Würzburg (Southern Germany) in 1483, where he worked in lime-wood, sandstone, and
106 limestone [14]. Until recently, only five alabaster sculptures were attributed to Tilman
107 Riemenschneider and his workshop [24], a Saint Jerome, now in The Cleveland Museum of Art,
108 the Virgin of the Annunciation held by the Louvre (Paris), a complete Annunciation group, Virgin
109 and Angel Gabriel, at the Rijksmuseum (Amsterdam), and a Saint Barbara, now in a private
110 collection in Bremen. Two bas-reliefs were newly added to Tilman Riemenschneider's alabaster
111 corpus, a Madonna and the Child in the lap of Saint Anne (a so-called Anna Selbdritt group), now
112 in the Museum für Franken (Würzburg) [25] and an Annunciation, formerly in a private collection
113 in Munich and exposed in the Munich National Museum, currently for sale [26]. Reputedly, altars
114 in the chantry of the Würzburg Cathedral were decorated with alabaster statues by Tilman
115 Riemenschneider's hand, now lost [24]. The Cleveland Saint Jerome and the Louvre Virgin can be
116 traced back to the collection of a clergyman in Erfurt [27], in the 19th century and are supposed to
117 have been commanded by the clergy of Erfurt for the church of Saint Peter abbey. They were sold

118 after 1892 from a private collection in Dieburg near Frankfurt [28] and their attribution to
119 Riemenschneider dates back to 1906 [29] for the Louvre Virgin and to 1909 [28] for the Cleveland
120 Saint Jerome.

121 Riemenschneider's infrequent alabaster works are rather largely spread in time [7]: they cover a
122 period from 1485-1487 (Amsterdam Annunciation group) to 1505-10 (Saint Jerome) [24, 30], all
123 dating being based on stylistic comparisons. The reasons for using alabaster intermittently can only
124 be suspected. The commands from Erfurt might have explicitly specified and even furnished the
125 material to be used [24]. Indeed, Permian alabaster was quarried north of Erfurt in the South Harz
126 region, notably in Nordhausen (Thuringia) but first written records on this deposit are from the
127 mid-16th century [31], and northwest of Erfurt in Witzenhausen (Hesse), exploited as early as
128 1458 [9]. Tilman Riemenschneider may have known alabaster from his youth in the Harz
129 region [14], as supposed by Justus Bier [24] but also discovered it in Southern Germany where it
130 abounds in the environs of his home town Würzburg.

131 In this study we report isotope analyses of a near complete corpus of the surviving
132 Riemenschneider alabaster sculptures (six out of seven) and a representative selection of sculptures
133 attributed to the Rimini group, including masterpieces like the Rimini altar and the Wrocław group
134 but also smaller individual works with undeniable serial production. Our data base on European
135 alabaster [15, 16] is completed by new data on historical quarries south German, Franconian
136 alabaster, one of the two possible sources for the Riemenschneider workshop.

137 **Materials and Methods**

138 **Sampling**

139 The required minimum quantity for a complete isotope analysis (Sr, S, and O isotopes) using the
140 method described in Kloppmann, Leroux (15) is less than 20 mg. This corresponds to a tiny flake
141 of around 2 x 2 x 2 mm. Flakes, sampled with a miniature chisel on a non-carved, non-visible

142 surface of the sculpture (e.g. rear surface or base) were preferred to micro-drilling for two reasons:
143 (1) It is possible to detect and correct any treatment or contamination of the surface by manual
144 cleaning under a microscope, (2) there is less aesthetic impact as the non-carved surfaces frequently
145 have defects such as drilled fixing holes or irregular surfaces allowing discrete sampling to be
146 undertaken. We strictly avoided any suspected or visible repairs or fixings where gypsum
147 plaster/mortar were present as these are highly contaminant for our method. We also avoided or
148 cleaned, whenever possible, any surface treatments (patina, wax, whitewash,...) to obtain unaltered
149 isotope signatures of fresh material.

150 **Analysis**

151 The samples are crushed, weighed and slowly dissolved in a closed tube filled with 50 ml of
152 Millipore® distilled water at 50°C in an oven for at least one week. After filtration, the 50 ml
153 solution is divided in three aliquots; two aliquots of 5 ml are used for Sr isotopes and elemental
154 analysis, the remaining 40 ml for sulphates isotopes. Sulphates are precipitated as BaSO₄ from the
155 filtered solution by adding BaCl₂ solution. The precipitate is then filtered off and left to dry and a
156 fraction (\approx 350 µg) of BaSO₄ is mixed with vanadium pentoxide in a tin capsule [32], injected in a
157 flash combustion elemental analyser (Flash EA) where BaSO₄ is reduced to SO₂ at 1700-1800°C.
158 The purified SO₂ is analysed for S isotopes by a continuous flow isotope ratio mass spectrometer
159 (CF-IRMS: Thermo Delta Plus XP). An aliquot of the BaSO₄ (\approx 200µg) is placed in a silver capsule,
160 injected in a high temperature conversion elemental analyser (TC/EA) reactor with a graphite insert
161 at 1450°C. The resulting CO is analysed by CF-IRMS for oxygen isotopes. The isotopic
162 composition of sulphur is expressed in the usual delta notation as a per mil (‰) deviation of the
163 heavy-to-light isotope abundance ratio ($^{34}\text{S}/^{32}\text{S}$, $^{18}\text{O}/^{16}\text{O}$) in the sample, with respect to international
164 standards. $^{34}\text{S}/^{32}\text{S}$, including previously reported values for the historical quarries [15, 16] have
165 been (re-)normalised to the V-CDT standard using the following most recent $\delta^{34}\text{S}$ values (‰ vs.

166 V-CDT) for the BaSO₄ sulphate reference materials provided by the IAEA and the NBS: IAEA-
167 SO-6 (-34.05‰), IAEA-SO-5 (0.49‰), NBS127 (21.12‰).

168 Oxygen isotopes are reported as $\delta^{18}\text{O}$ with respect to the V-SMOW standard. Sulphur and oxygen
169 isotopes are measured twice. The error, based on repeated measurements of international and in-
170 house standards, is 0.5‰ for $\delta^{18}\text{O}$ and 0.3‰ for $\delta^{34}\text{S}$ (1σ).

171 Chemical purification of Sr is performed using an ion-exchange column (Sr-Spec) before mass
172 analysis according to a method adapted from Pin and Bassin [33], with total blank <1 ng for the
173 entire chemical procedure. After chemical separation, around 150 ng of Sr is loaded onto a tungsten
174 filament with a tantalum activator and analysed with a Finnigan MAT262 multi-collector thermal
175 ionization mass spectrometer (TIMS). The measured $^{87}\text{Sr}/^{86}\text{Sr}$ ratios are normalized to a $^{86}\text{Sr}/^{88}\text{Sr}$
176 of 0.1194 and then adjusted to the NBS987 standard value of 0.710240. An average internal
177 precision of $\pm 10 \times 10^{-6}$ ($2\sigma_{\text{m}}$) was currently obtained during this study and the reproducibility of
178 the $^{87}\text{Sr}/^{86}\text{Sr}$ ratio measurements was tested through repeated analyses of the NBS 987 standard for
179 which we obtained a mean value of $0.710245 \pm 11 \times 10^{-6}$ (2σ ; $n = 324$) during the period of analysis.

180 Results

181 Artwork included in this study

182 We have obtained and analysed samples from fifteen artworks attributed to the “Master of Rimini
183 cycle”, his own hand, his workshop and hypothetical followers, now scattered worldwide. Our
184 corpus includes four statues and groups from his most prominent opus, the Rimini altarpiece,
185 recently restored at the Liebieghaus Museum (Frankfurt, Germany), plus one later replacement.
186 The other works are an Apostle (RF 4402) and the Swoon of the Virgin (RF 1639) from the Louvre
187 Museum (Paris, France), the Saint Philip (2015.58) of the J. Paul Getty Museum (Los Angeles,
188 USA), the Swoon of the Virgin (the so-called “Three Maries” group, Šr.402) of the National

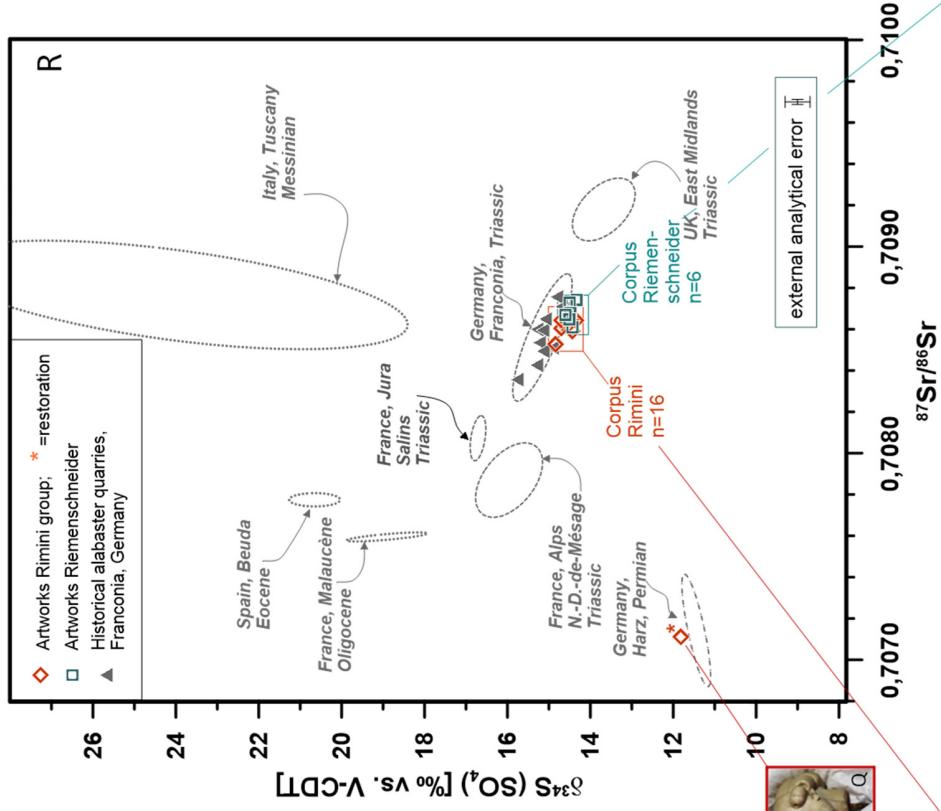
189 Museum of Warsaw (Poland), the Pietà (BK11667) of the Rijksmuseum (Amsterdam,
190 Netherlands), the Pietà (P 1990/13) of the Mittelrheinmuseum (Koblenz, Germany), the Pietà (Inv.
191 491) of the Museum am Dom (Würzburg, Germany), and the Pietà of the Deutschordensmuseum
192 (Bad Mergentheim, Germany). Two of the four Apostles (2911.3 and 2911.4) of the Musée de
193 l'Hôtel Sandelin (Saint-Omer, France) were investigated, as well as one Apostle and his pedestal
194 in the Saint Viktor church in Schwerte (Germany), where eight alabaster apostles and a Christ in
195 Majesty were integrated in a later wooden Antwerp altarpiece.

196 Of the seven known alabaster works attributed to Tilman Riemenschneider and his workshop, we
197 have been able to characterize six, including the Saint Jerome (CMA 1946.82), held by the
198 Cleveland Museum of Fine Art (Ohio, USA), the Virgin of the Annunciation (RF 1384) at the
199 Louvre, the Annunciation Virgin and Angel (BK-16986-A and B) at the Rijksmuseum, the Anna
200 Selbdritt (ZV67983) of the Museum für Franken (Würzburg, Germany), and the Annunciation
201 currently at the Daniel Katz Gallery (London, UK).

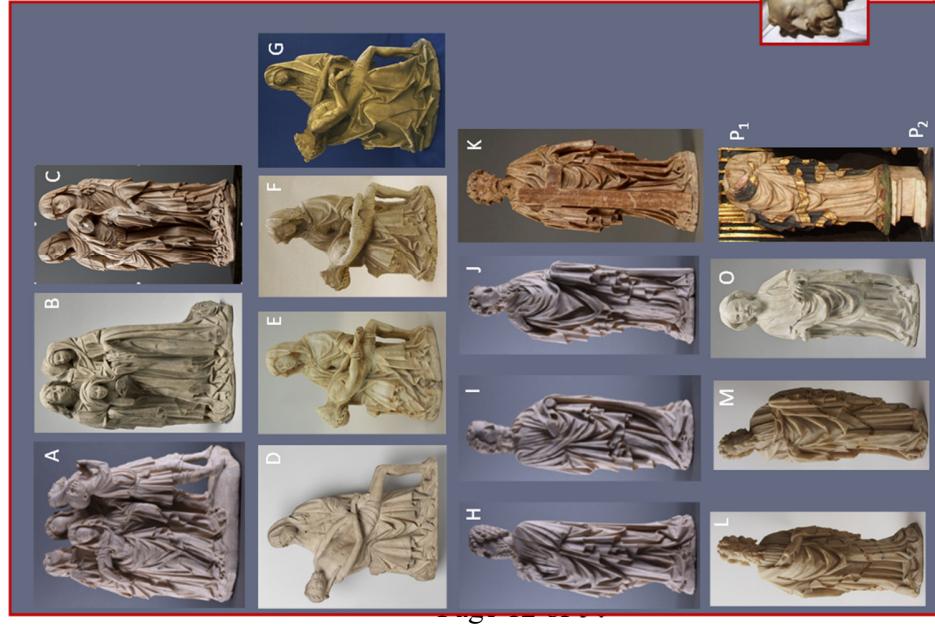
202 Details and references are provided in S3 Table, images in Fig. 2.

203

Tilman Riemenschneider and workshop



Master of Rimini group



205 **Fig. 2 Isotope fingerprints of the artwork attributed to the workshops of the Rimini**
206 **Master and Tilman Riemenschneider and of the historical alabaster quarries in**
207 **Franconia (Germany). A-M: Master of Rimini group. A-C:** Swooning Mary groups (A:
208 Liebieghaus Museum, Rimini altarpiece, B: Louvre Museum, C: National Museum of
209 Warsaw); **D-G:** Pietàs (D: Rijksmuseum, Amsterdam, E: Mittelrheinmuseum Koblenz, F:
210 Museum am Dom, Würzburg, G: Deutschesordensmuseum, Bad Mergentheim); **H-P:** Apostles
211 (H-J: Rimini Altarpiece, Liebieghaus Museum, Frankfurt, K: J. Paul Getty Museum, **L-M:**
212 Musée de l'Hôtel Sandelin, **O:** Louvre Museum, P₁-P₂: Schwerte, Saint Viktor church). **Q:**
213 Replacement of the head of Saint Peter, Liebieghaus Museum, Rimini altarpiece. **R:** $\delta^{34}\text{S}$ vs.
214 $^{87}\text{Sr}/^{86}\text{Sr}$ for artwork and Franconian quarries. For comparison: principal deposits
215 previously identified to have delivered alabaster for 14th to 16th century sculpture in W
216 Europe [15, 16], renormalised to V-CDT. **S-W: Tilman Riemenschneider and workshop.** S-
217 U: Annunciation groups (S: Louvre Museum, T-U: Rijksmuseum), V: Saint Jerome, Cleveland
218 Museum of Fine Art, W: Madonna and the Child in the lap of Saint Anne, Museum für Franken,
219 X: Annunciation, D. Katz Gallery. **Photographic credits:** Louvre Museum (B, O, S), National
220 Museum of Warsaw (A), Liebieghaus Museum (C, H, I, J), Rijksmuseum (D), J. Paul Getty
221 Museum (K), Cleveland Museum of Fine Art (V), D. Katz Gallery (X). Other photos (E, F, G,
222 L, M, P, Q, T, U, W) by WK.

223 Identification of historical quarries in Southern Germany

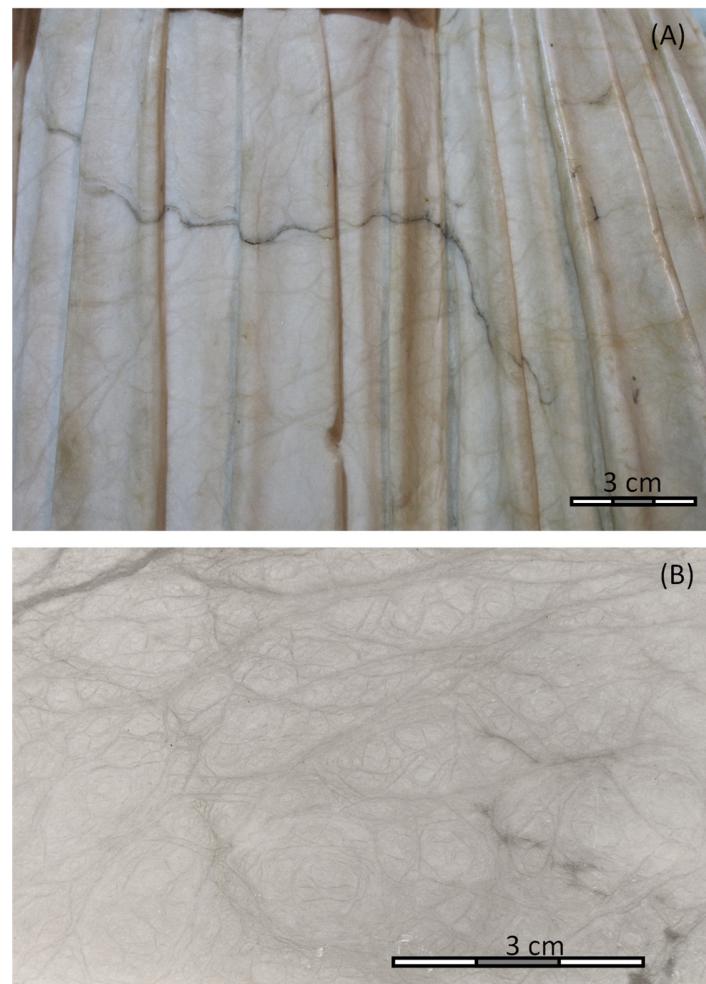
224 The hypothesis of a South German or Central German origin for the alabaster used by Tilman
225 Riemenschneider directed our research to the Würzburg region (Franconia, N-Bavaria, Germany).
226 Geologically, all Franconian alabaster belongs to the Upper Triassic Ladinian to Karnian (Keuper)
227 evaporites [34] that regionally comprise two gypsum complexes intercalated in grey, green and
228 dark red marls: a massive white gypsum bank of around 10 m (the so-called “Grundgips”) and a

229 less continuous level of gypsum nodules, attaining diameters up to 1.1 m, locally forming “nests”.
230 This higher level has delivered alabaster, frequently containing argillaceous flasks and veins and
231 rarely pure white whereas some coloured varieties were sought for [34].

232 The gypsum industry was and is still active in this region but the historical alabaster quarries in
233 Southern Germany (Franconia) are scarcely documented in recent literature [34]. Fortunately we
234 dispose of two 18th century sources describing in detail the ancient alabaster exploitations of
235 Castell [35] and of Ickelheim [36], respectively 35 and 65 km SE from Würzburg. The Castell
236 alabaster with a grey, a white and a reddish variety was used at least from the 16th century onwards.
237 The first written source on its use [35] dates back to 1578 and it was widely employed in the 16th
238 to 18th centuries for decorative elements in religious architecture, mainly the grey variety due to its
239 resemblance to marble. Following the anonymous description [35] of 1791, we localized the
240 historical exploitations accurately to a few 100 m and analysed three samples of massive and
241 nodular alabaster.

242 The Ickelheim deposit is described in great detail by Hofmann in 1757. He states the opening, of a
243 “new quarry”, in 1748, whereas the nearby “old quarry” had reputedly been exploited for “400
244 years”. He also mentions the exploitation of alabaster nodules from the vineyards in the vicinity,
245 with frequent large scale transports to Nuremberg. His description of the material is most
246 intriguing: the colour is “throughout white” with “subtle veins of the same white colour” whereas
247 some nodules contain black veins. This corresponds precisely to Kim Woods’ macroscopic
248 description of the material used by the Master of Rimini [1] (Fig. 3). The dimensions he provides
249 for the “stones” or nodules are mostly 30x60 cm whereas some may attain 200-300 kg so that, for
250 funeral effigies, “four of them need to be skilfully assembled”. We indeed state that neither of the
251 individual statues in our corpus exceeds 60 cm. One exceptional case of a bigger sculpture
252 associated to the Rimini workshop, the Pietà [22] of the Louvre Museum (R.F. 1807, H: 0.95, W:

253 0.83 m., D: 0.38 m), not included in this study due to its fragility, is distinctly composite and not
254 monolithic. For some sculptures related to the Rimini group, it has been supposed that their
255 geometry was determined by the dimensions and rounding of the used alabaster piece, notably for
256 the Mergentheim Pietà [37] (Fig. 2G) so that it is likely that indeed nodules and not banked
257 alabaster levels were used.



258
259 **Fig. 3 Characteristic clear grey and dark veins of the alabaster used by the Rimini**
260 **workshop. (A)** Back side of the Swooning Mary group of the Rimini Crucifixion,
261 Liebieghaus Skulpturensammlung **(B)** polished surface of the Ickelheim alabaster

262

263 Hofmann's topographic description is sufficiently precise to locate with a high degree of
264 confidence the historical locations of the "new" and also of the "old" quarry even if the alabaster
265 hosting marls are rapidly eroded. The Ickelheim vineyards are still delivering alabaster nodules of
266 decimetric size. On total, we analysed four nodules and fragments from four different locations SE
267 of the village.

268 The third sampled Franconian deposit of similar geological age (three samples), Markt Seinsheim,
269 is mentioned in 1840 to have delivered alabaster and gypsum [38]. We sampled white gypsum
270 from abandoned exploitations at two different locations in distinct stratigraphic positions: the
271 Karnian massive stratiform "Grundgips" layer, and the Ladinian to Karnian massive to nodular
272 alabaster contained in the marls of the Estheria beds.

273 Details are provided in S2 Table.

274 Isotope fingerprinting

275 All samples were analysed for their isotopic composition of strontium, sulphur and oxygen,
276 following the protocol described in the Materials and Methods section. Results are provided in S3
277 Table, Fig. 2 and S4 Fig.

278 All sculptures of our Rimini corpus show very homogeneous strontium and sulphur isotope
279 signatures compared to the overall variability of the alabaster deposits [15] with mean values and
280 standard deviations of respectively 0.70862 ± 0.00003 ($n=16$) for $^{87}\text{Sr}/^{86}\text{Sr}$ compared to an
281 analytical uncertainty around 0.000007, and of $14.6 \pm 0.1\text{‰}$ vs. V-CDT ($n=16$) for $\delta^{34}\text{S}$. For $\delta^{34}\text{S}$,
282 the standard deviations are smaller than the analytical uncertainty of 0.3 %. Oxygen isotope values
283 are more variable with a mean $\delta^{18}\text{O}$ of $12.8 \pm 0.8\text{‰}$ vs. V-SMOW ($n=16$) compared to an
284 analytical uncertainty of 0.5 %. The head of Saint Peter in the Rimini Altarpiece now in the
285 Liebieghaus (INV 418), considered as a later addition, clearly represents an outlier, with a $^{87}\text{Sr}/^{86}\text{Sr}$
286 of 0.707111 ± 0.000008 and a $\delta^{34}\text{S}$ of $11.8 \pm 0.3\text{‰}$ vs. V-CDT (Fig. 2Q).

287 The values of the artworks attributed to Tilman Riemenschneider and workshop fall in the same
288 field as the Rimini sculptures (Fig. 2R) with mean values, respectively for $^{87}\text{Sr}/^{86}\text{Sr}$, $\delta^{34}\text{S}$, and $\delta^{18}\text{O}$,
289 of 0.70868 ± 0.00005 (n=6), $14.5 \pm 0.1 \text{ ‰}$ vs. V-CDT (n=6), and 12.8 ± 0.9 vs. V-SMOW.

290 The Franconian quarries in the Steigerwald region SE of Würzburg show a mean $^{87}\text{Sr}/^{86}\text{Sr}$ of
291 0.70856 ± 0.00012 (n=10). The mean $\delta^{34}\text{S}$ value is $15.1 \pm 0.3 \text{ ‰}$ vs. CDT (n=10) and the mean
292 $\delta^{18}\text{O}$ is $13.5 \pm 0.4 \text{ ‰}$ vs. V-SMOW (n=10). For the both latter elements, the standard deviation of
293 the raw materials is smaller than the analytical uncertainty. No distinction of the individual quarries
294 (Ickelheim, Castell, Markt Seinsheim) is possible in this group based on isotopic compositions.

295 Discussion

296 The most striking fact of our results is the isotopic homogeneity of the artworks attributed to the
297 Rimini Master and workshop, compared to the overall variability of the principal European
298 alabaster deposits [15] (Fig. 2R). This is particularly true for the Sr and S fingerprints whereas the
299 oxygen signatures are more variable, which is usually the case for the gypsum and anhydrite so far
300 investigated [15]. We can conclude that the Rimini workshop used a single source of alabaster
301 supply, likely a single quarry, which is compatible with the visual homogeneity of the material
302 stated before [1]. This fact is most astonishing in the context of the current hypothesis of the
303 workshop being situated in or around Flanders. The Low Countries have indeed a strong tradition
304 of alabaster carving but no local alabaster sources. Given the large variety of provenances of
305 imported material available to a supposedly Flemish workshop, the very selective supply would
306 indicate either an aesthetic choice or a strong traditional, commercial or personal link with a
307 particular alabaster-producing region. The homogeneous isotope signatures also corroborate the
308 stylistic attribution of all investigated alabaster sculptures to a common workshop or group of
309 workshops, indicating that the “Rimini-style” is indeed recognizable among those of the early 15th
310 century, albeit the material may have played some role in the attributions. This homogeneity

311 concerns both the masterpieces attributed to the hand of the Rimini Master himself and minor
312 pieces like the Pietà groups (Fig. 2D-G) that have been supposed to be, at least partly, serial
313 workshop productions [4]. Particularly instructive examples in this respect are the Pietà groups
314 conserved in Koblenz (Fig. 2E) and Würzburg (Fig. 2F) virtually identical in their dimensions and
315 details. Material homogeneity indicates a strong link between the workshop leader and apprentices
316 and maybe also possible imitators or followers. If the latter existed, they used the same material
317 which, again, indicates either a close aesthetic association of the sought style with a specific type
318 of alabaster or a local/regional supply for the main workshop and possible satellite workshops.
319 Similarly, the Riemenschneider workshop used a single alabaster source, in spite of the only
320 occasional employ of this material and the large temporal spreading of the concerned artworks.

321 None of the historical European deposits identified previously [15], corresponds to the observed
322 isotope signatures of the two artwork corpuses. The fact that the geochemical signatures of the
323 productions of the Rimini and Riemenschneider workshops are identical for the investigated
324 corpuses, points to a South-German supply for both.

325 Concerning the two hypotheses prevailing so far on the scarce alabaster sculptures by Tilman
326 Riemenschneider and his workshop [1], we can rule out with certainty that the historical material
327 originates from the Permian gypsum and anhydrite deposits of the Harz mountains, their very
328 distinctive fingerprints being incompatible with those of the artworks. The remaining hypothesis
329 for the original material is that of a local supply around the city of Würzburg where
330 Riemenschneider resided for nearly five decades. Indeed, we state that the Franconian alabaster
331 deposits of the Steigerwald region E and SE of Würzburg, different from all other European
332 deposits so far investigated, are the only with isotopic fingerprints compatible with both those of
333 the Rimini and Riemenschneider corpuses, the most discriminating parameters being strontium and
334 sulphur isotopes.

335 The only notable exception is the head of Saint Peter as part of the Rimini crucifixion (Fig. 2Q)
336 with a clearly Permian sulphate isotope composition that can be linked to the Harz alabaster
337 quarries near Nordhausen. The Saint Peter was headless when Swarzenski acquired it in 1913 [3,
338 4] for the Liebieghaus and was combined with an existing head, most likely dating from the 19th
339 century.

340 The Ickelheim alabaster is the only of the investigated Franconian deposits to show the distinctive
341 macroscopic features observed for the Rimini sculptures (Fig. 3). Also, the dimensions of the
342 artwork are compatible with the use of gypsum nodules as stated by our 18th century source [36]
343 from the Ickelheim quarries. The duration of four centuries of exploitation of the Ickelheim quarries
344 mentioned by Hofmann in 1757, though to be taken with care, would include the production phases
345 of the Rimini and Riemenschneider workshops. We thus postulate that the Ickelheim quarries are
346 the most likely source of supply for both.

347 Concerning the supply and location of the Rimini workshop, two new scenarios come into question:

348 **(1) The workshop was situated in the Southern Netherlands or in Northern France and
349 was exclusively supplied with Franconian alabaster.** This scenario is based on the
350 current consensus on the influence of Flemish painting on the style of the Rimini sculptures,
351 notably of the Master of Flemalle [4], and on the scarce hints on the Parisian art market for
352 the trade of the Rimini productions, notable for the Wrocław group [10].

353 **(2) The Rimini workshop was situated near the Franconian deposits and used exclusively
354 the material easily available near its doorstep,** as it is evident for the Riemenschneider
355 alabaster production. The Rimini Master might, in this case, have received his education in
356 the Franco-Flemish sphere or been strongly inspired by the art of this region, marking his
357 iconography and style along with other sources of influences, particularly from Central
358 European art [13].

359 We cannot, based on isotope fingerprinting alone, decide between both scenarios, yet our findings
360 prove a voluntary choice of the material, either for aesthetic or for practical/economic reasons.

361 The first scenario would imply a transport of more than 600 km from the Franconian quarries to
362 the Netherlands, to Bruges, suggested by Kim Woods as a possible location of the workshop [1,
363 2]. Trade of raw materials over long distances is now well documented [39], for English
364 alabaster [15, 40], the French Alpine deposits [15] and, to a lesser extent, of Spanish material
365 (notably for the Beuda quarries [15]). The Main and Rhine rivers may have served for fluvial
366 transport, the Ickelheim quarries being situated 37 km from the Main river (Fig. 1), the latter
367 flowing to the Rhine, navigable as far as the Southern Netherlands since antique times [41].
368 Furthermore, the dimensions of the blocs are rather modest, all below 60 cm for our corpus,
369 facilitating transport, a specificity of the Rimini sculptures pointed out by Legner [4].

370 However, the first scenario raises a number of questions: If the workshop was situated in the
371 Southern Netherlands or in Northern France, why did it not use easier available material, e.g.
372 English alabaster from the East Midlands or French Alabaster from the Alpine deposits, known to
373 have transited at this time to and through France [15]? Why did the Rimini Master choose
374 Franconian alabaster for his workshop? Here, we may postulate that he knew these deposits,
375 perhaps due to German roots, and for some (aesthetic, relational, economic?) reasons clung to them
376 during the whole lifetime of his workshop. We have other examples of such a conservatism in the
377 choice of a specific material, e.g., fifty years later, the sculptor Martin Claustre, originating from
378 Grenoble, who continued using the alpine alabaster of Notre-Dame-de-Mésage, long after having
379 left the Dauphiné region [42]. The last question is the most intriguing one: If a Europe-wide export
380 of Franconian alabaster existed, why do we find its fingerprints in none of the other medieval and
381 early modern European artworks published so far [15, 16]? One can argue that the total number of
382 analyses is still quite limited, compared to the existing alabaster European artwork of the late

383 Middle Ages, and that there are some inevitable biases of sampling. Notably, the 15th century
384 alabaster sculpture from the Low Countries was in large parts destroyed by the iconoclast
385 Reformation movements of the 16th century and is therefore inaccessible to investigation. German
386 alabaster sculpture is so far underrepresented in our corpus. Nonetheless, the 15th cent. use of
387 Franconian alabaster appears, at the present state of our research, focused on and exclusive for two
388 workshops, plus eventual followers, one of them, the Riemenschneider workshop, being situated
389 with certitude in the Franconian region.

390 This provides some arguments for the second scenario, a regional anchoring of the Rimini
391 workshop in Southern Germany. In this case, why does the style and iconography of the Rimini
392 group show such close links with Flemish art, alongside other influences [4, 8, 13]? Before the
393 second half of the 15th century, artist biographies are rarely known with sufficient detail to
394 reconstruct their mobility. Hypotheses of artist itinerancy were so far largely based on stylistic
395 considerations and the idea of non-resident artists wandering from town to town in Europe, thus
396 transmitting new stylistic tendencies (“Wanderkünstler”). This concept was later qualified as a
397 “scientific myth” for individual sculptures [43], even if it still holds for cathedral building lodges.
398 Later and better documented *vitae* show, that, indeed, Flemish artists in the late 15th and the early
399 16th century migrated all over Europe, including Spain [44], England [45] and Germany [46], thus
400 disseminating the Flemish style and making it the international reference of the time. A prominent
401 example of a migrating albeit not itinerant artist is the sculptor Nicolas Gerhaert born in Leyden
402 around 1420 who installed a workshop in Strasbourg before 1463, and accepted in 1467 an offer
403 of the Emperor and moving to the imperial residence of Wiener Neustadt where he died in
404 1473 [47].

405 The Rimini Master could be considered as an earlier example of such international mobility. Yet,
406 the constancy of supply clearly contradicts the hypothesis of an itinerant artist [43] introduced at

407 the beginning of the Rimini research by Swarzenski [3] and Körte [48] and confirms the prevailing
408 theory of a geographically stable, highly specialized export workshop. We may postulate that it
409 was run by a sculptor who, having received his education or artistic inspiration in the Flemish
410 sphere, installed his workshop in Southern Germany. Like later Nicolas Gerhaert in Strasbourg [49]
411 and the numerous Flemish artists working in Spain [50, 51] in the second half of the 15th century,
412 he might have sought to escape the constraints of the rigid guild system of towns in the Low
413 Countries like Bruges which throttled artistic innovation [50]. Furthermore, as Jolly states for
414 Flemish sculptor's migration to early Renaissance Germany, another motivation might have been
415 the readily available raw material inexistent in the Netherlands [46].

416 A potential candidate for the Rimini workshop's location is the town of Nuremberg, 52 km east
417 from the identified alabaster deposits (Fig. 1), where we have evidence of a long-lasting tradition
418 of alabaster carving. In Nuremberg, up to the end of the 17th century this profession was considered
419 as "free art", facilitating the access for any gifted artisan without requirement of a masterpiece [52],
420 as opposed to "sworn crafts", the latter being overseen by a master [53]. The craftsmen's revolt of
421 1349 had led to an abolition of the guild system, Nuremberg's Lesser Council taking the entire
422 governance of the local craft and trade [54]. Only in 1698 a guild of alabastermen ("Alabasterer")
423 was founded leading to a culmination of activity till the 1720s [52]. By the end of the 18th century,
424 this profession seems to have virtually vanished [52]. The oldest explicit mention of an alabaster
425 carver in Nuremberg dates from 1441 [55] when a Martin Guldein became citizen, proving that, in
426 the early 15th century, specialized artists were active in the region. They probably already relied on
427 local supply, thus corroborating Hofmann's statement of a long-lasting activity for the Ickelheim
428 quarries [36]. He mentions that "in the past, frequently 40 to 50 cartloads of such stones" from the
429 Ickelheim vineyards "parted to the Imperial town of Nuremberg, a meeting place of artists". The
430 attractiveness of the Imperial City of Nuremberg as a leading centre of craft production is indeed
431 directly related to its Lesser Council's policy [54]. From the second half of the 14th century

432 onwards, it facilitated, through a strong reduction of the regulatory burden, in particular for the
433 “free arts” including sculpture, the immigration, settlement and work of a large number of talented
434 artists [54].

435 A vast network of commercial relations radiated from the postulated highly productive South
436 German production centre of alabaster sculpture both to the South, across the Alps to Northern
437 Italy, and, eventually via Paris, to Northern France and to other European capitals. This is
438 illustrated by the altarpieces of Rimini and Isola Bella (formerly in Milano), Saint-Omer and,
439 potentially, the lost ensemble of Arras, the altarpieces of Schwabstedt and Schwerte in Northern
440 Germany, as well as the crucifixion group from Wrocław (Fig. 1). The Imperial City of Nuremberg
441 might have favoured the development of such a network. At the crossroads between Central and
442 Western Europe, between the Hanse and Northern Italy, the town benefited from imperial
443 protection and freedom of trade since the 12th century [56]. It developed a farsighted policy of free
444 trade agreements and merchant mobility with all major trade centres of Europe, from Lübeck to
445 Venice, Bruges to Cracow and Wrocław [56]. There have been strong economic and artistic links
446 between Nuremberg and Wrocław, facilitating direct art trade of Franconian artwork delivered to
447 Silesia [54] even if the Wrocław alabaster group seems to have transited through the anonymous
448 art market via Paris. Such modern forms of the art market developed, including art centres in
449 Southern Germany, in parallel to traditional lines where art trading agents linked workshops to
450 wealthy patrons [57]. As stated by Woods [1] the outstanding quality of the Rimini Master’s
451 personal production met the demands of the upper end of the market, similarly to the more or less
452 contemporaneous paintings of Van Eyck. Direct commissions from high-ranking clients like the
453 Milanese Borromei and, most likely, the Malatestas of Rimini [1] could have prevailed for the few
454 conserved masterpieces whereas the workshop production, including serial production of
455 devotional objects, eventually also by followers, would rather be intended for the open market [4].
456 This could also explain why none of the known masterpieces of the workshop were initially situated

457 in the Nuremberg and even Franconian region whereas several lesser artworks, mainly Pietàs as
458 our examples from Würzburg and Bad Mergentheim (Fig. 2F-G), can be traced back to churches
459 in Southern Germany [37, 58].

460 Our results provide a means to better constrain the large and somewhat protean Rimini alabaster
461 corpus as it is obviously possible to identify unambiguously the preferred material used by this
462 workshop. They should also help to geographically focus future historical research targeting so far
463 unreported written evidence of the workshop's activities. Our study illustrates how independent
464 archaeometric methods can shed a new light on the art historical discussion on artist mobility and
465 art trade routes prior to the mid-15th century in a context of still sparse written sources on artist
466 identities and *vita*e and the more than patchy records of individual art trade transactions. Stylistic
467 analyses, inevitably subjective to some extent, have been the main arguments for geographically
468 situating the Rimini workshop with its pan-Europe radiance, with quite contradictory results. Even
469 if the material sciences cannot provide an ultimate answer to the enigma of the Master of Rimini,
470 we provide corroborating evidence on a territorial anchorage within or a strong link to Southern
471 Germany, thus re-opening a debate that otherwise seemed to have come to a dead-end.

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508

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659 Supporting Information

660 **S1 Appendix. Complementary findings on the 1431 purchase of the Wrocław alabaster group**
661 **by the abbot Jodocus for the Augustinian monastery of our Lady of the Sand from a French**
662 **merchant**

663 **S1 Fig. Manuscript IV Q 205, ff. 37v-64 chart.**, the *Chronica abbatum Beatae Mariae virginis*
664 *in Arena* from 1470, University Library of Wrocław, by the hand of Abbot Benedict Johnsdrorff,
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665 successor of Jodocus Czeginhals. The passage concerning the acquisition of the alabaster Calvary
666 in 1431 and the subsequent purchase of a group of sculptures arranged on a support in the form of
667 mountains is highlighted. The decisive passage (double highlighted) on the origin of the alabaster
668 group reads here “parisius cum montanis”.

669 **S2 Fig. Manuscript IV F 200b, pp. 69-111 chart.**, University Library of Wrocław, a copy from
670 1609 of the *Chronica abbatum Beatae Mariae virginis in Arena*. The same passage as in S1 Fig.
671 concerning the alabaster purchase is highlighted. The passage on the provenance is double
672 highlighted.

673 **S3 Fig. Alabaster Crucifixion mounted in a Calvary arrangement**, Halberstadt Cathedral,
674 around 1460, © Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, Juraj Lipták

675 **S1 Table. Analyzed artwork.** Artwork attributed to the Rimini group and to Tilman
676 Riemenschneider's workshop analysed in this study, supposed period of creation, dimensions,
677 original situation of the artwork if known, current situation/collection and context.

678 **S2 Table. Analyzed historical quarries** Franconian alabaster deposits and their isotopic
679 composition.

680 **S3 Table. Isotope signatures of artwork**

681 **S4 Fig. Isotope fingerprints of sulphur vs. oxygen ($\delta^{34}\text{S}$ vs. $\delta^{18}\text{O}$) of the artwork attributed to
682 the workshops of the Rimini Master and Tilman Riemenschneider and of the alabaster
683 quarries in Franconia (Germany).** For comparison: principal deposits previously identified to
684 have delivered alabaster for 14th to 16th century sculpture in W Europe [15, 16], $\delta^{34}\text{S}$ renormalised
685 V-CDT.

Supplementary Information

Title

A pan-European art trade in the Late Middle Ages: Isotopic evidence on the Master of Rimini enigma

Authors

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S1 Appendix

Complementary findings on the 1431 purchase of the Wrocław alabaster group by the abbot Jodocus for the Augustinian monastery of our Lady of the Sand from a French merchant

Only two written sources from the period of activity of the Rimini workshop are known referring to international trade of alabaster sculptures potentially linked to the Rimini group. One is part of the records of Abbot Jodocus of the Augustinian monastery of Wrocław who acquired in 1431 a Crucifixion group from a “Parisian” merchant. This source is all the more noteworthy as one surviving sculpture from this Crucifixion has been identified, the Swooning of the Virgin group, now conserved in the National Museum of Warsaw. It is included in the corpus of our study (Fig. 2C).

The obscure expression “*parysiis in montanis*” referring to the origin of the sculpture has been subject to discussion since this source was first related to the Wrocław Swooning Virgin by Scheyer in 1933[1]. He explains the phrase “*qui mercator affirmavit praefatam imaginem crucifixi sculptam parysiis in montanis*” in the following way: The Parisian merchant claims a Parisian origin of the sculpture, “*parysiis in montanis*” referring to the topography of the “hilly” Paris and perhaps to the Montmartre gypsum deposits, even if he judges this hypothesis as unlikely. All later literature cites the expression after Scheyer (1933).

Based on an earlier reference and on the original manuscripts conserved in the University Library of Wrocław (references IV Q 205, ff. 37v-64 chart. and V F 200b, pp. 69-111 chart.), we propose a new reading of this passage, crucial for the Rimini research, and postulate that the enigmatic expression is in fact a transcription error.

Indeed, after Stenzel (1839), the original manuscript of Jodocus has been lost and two transcriptions exist, one from 1470 by the successor of Jodocus and the other from the beginning of the 17th century. Stenzel edits the older version and here the decisive phrase reads: “*qui mercator affirmavit, prefatam ymaginem crucifixi sculptam in Parisius cum montanis*” (S1 Fig.). This expression “*cum montanis*” could refer to the physical support of the Crucifixion group, in form of mountains, so that the phrase can be translated as “This merchant confirmed that the crucified Christ's representation had been sculpted, together with mountains/with a mountain-shaped base, in Paris”. This would mean that “*montanis*” refers to a Calvary-type arrangement for the Wrocław ensemble, similar to the alabaster Crucifixion conserved in the Halberstadt cathedral (Germany), made by a sculptor inspired by the Rimini Crucifixion or another altarpiece from the Rimini workshop [2] (S3 Fig.). In Halberstadt, the sculptures are based on a wooden structure in form of hills and assembled as a “*Kalvarienberg*”, a Calvary. It is likely that this altarpiece is still in its original position and in its original order[2]. This reading of “*montanis*” as “mountain-shaped support” for the Wrocław group is supported by the following passages in Stenzel’s version, mentioning, for another ensemble of sculptures: “*montana minerarum, artificialiter et subtiliter multum facta*”, “mineral mountains, made with great art and refinement”, supporting groups of small figures, which have later collapsed by negligence of the sacristans.

In the following, we present the original Latin text of the 1470 transcription of Jodocus’ lost manuscript in Stenzel’s edition as well as an English translation, based on the translation

into German kindly provided by Prof. Dr. Gerhard Weilandt (University of Greifswald) and on the initial French translation kindly rendered by Françoise Lami, Orléans.

Item, anno domini MCCCCXXXI, circa festum sancti Johannis baptiste, dominus Jodocus abbas emit a quodam mercatore de Parisius tabulam cum crucifixo de alabastro laboratum cum suis attinenciis, sitam in altari s. Augustini pro XL. florenis Ungaricis, qui mercator affirmavit, prefatam ymaginem crucifixi sculptam in Parisius cum montanis sed tabulam idem mercator Wratislavie ad eandem ymaginem fieri disposuit, pro qua X. marcas denariorum exposuit. Et eodem anno, in die s. Elyzabeth, idem dominus Jodocus abbas solvit Johanni Crommendoff aurifabro XX. marcas latorum grossorum in auro racione ejusdem tabule et laborum circa eandem, ut patet in libro annotacionum ejusdem. Item, eodem anno idem dominus Jodocus abbas apud quendam Smedchen, civem Wralislaviensem, emit quedam montana minerarum, artificialiter et subtiliter multum facta, cum tribus regibus et montanorum fossoribus et Christofero et aliis ymaginibus parvis et subtilibus, pro XXVI. florenis Ungaricis, que montana postea per incuriam custodum ecclesie sunt collapsa, confracta et deperdita.

“Likewise, in the year of the Lord 1431, around the feast of Saint John Baptist, the Abbot Jodocus bought from a certain merchant from Paris an altar table/shrine with the crucified Christ, which was made of alabaster, with associated parts, situated at/in the altar of Saint Augustine, for 40 Hungarian guilders/florins. This merchant confirmed that the crucified Christ's representation had been sculpted, together with mountains/with a mountain-shaped base (cum montanis), in Paris, but this merchant had the altar table/shrine for this sculpture made in Wrocław, for which he spent 10 marks of pennies. And in the same year, on the day of Saint Elisabeth, the same Abbot Jodocus paid Johann Crommendorff, goldsmith, 20 marks of thick groats/Groschen in gold on the account of this altar table/shrine and the related works, as it is written in the book of his notes. Likewise, in the same year, the Abbot Jodocus bought from a certain Smedchen, citizen of Breslau, certain mineral mountains (montana minerarum), made with great art and refinement, with the Three Kings and miners and Saint Christopher and other small and delicate representations for 26 Hungarian guilders/florins. These mountains/mountain-shaped base (montana) later collapsed, broke and were lost due to the carelessness of the sacristans of the church.”

In the 1609 copy, the passage “*Parisius cum montanis*” initially read, like in the original, “*parisiūs cū (m) mó (n)tanis*” but was changed by a later hand into “*parisiis in montanis*” by transforming the “ū” of “*parisiūs*” into a double “i” and the “c” of “*cū (m)*” into an “i” and the “ū” into an “n” (S2 Fig.).

Scheyer refers to an 18th century, copy of the text, „*Chronicum compendiosum complectens Canoniam Wratislavienscm in Arena . . . ab anno 1108 usque ad annum 1726 Balthasare Antonio Biener*“ (Breslau Diöz. Archiv V, 4). This version takes over the corrections to the 1609 manuscript. Furthermore, it seemingly introduces new transcription errors: Scheyer's version also mentions an altar dedicated to “Augustus” (“*Augusti*”) which is an obviously erroneous copy of “*altari s. Augustini*” dedicated to Saint Augustin, correctly spelled in the 1609 copy.

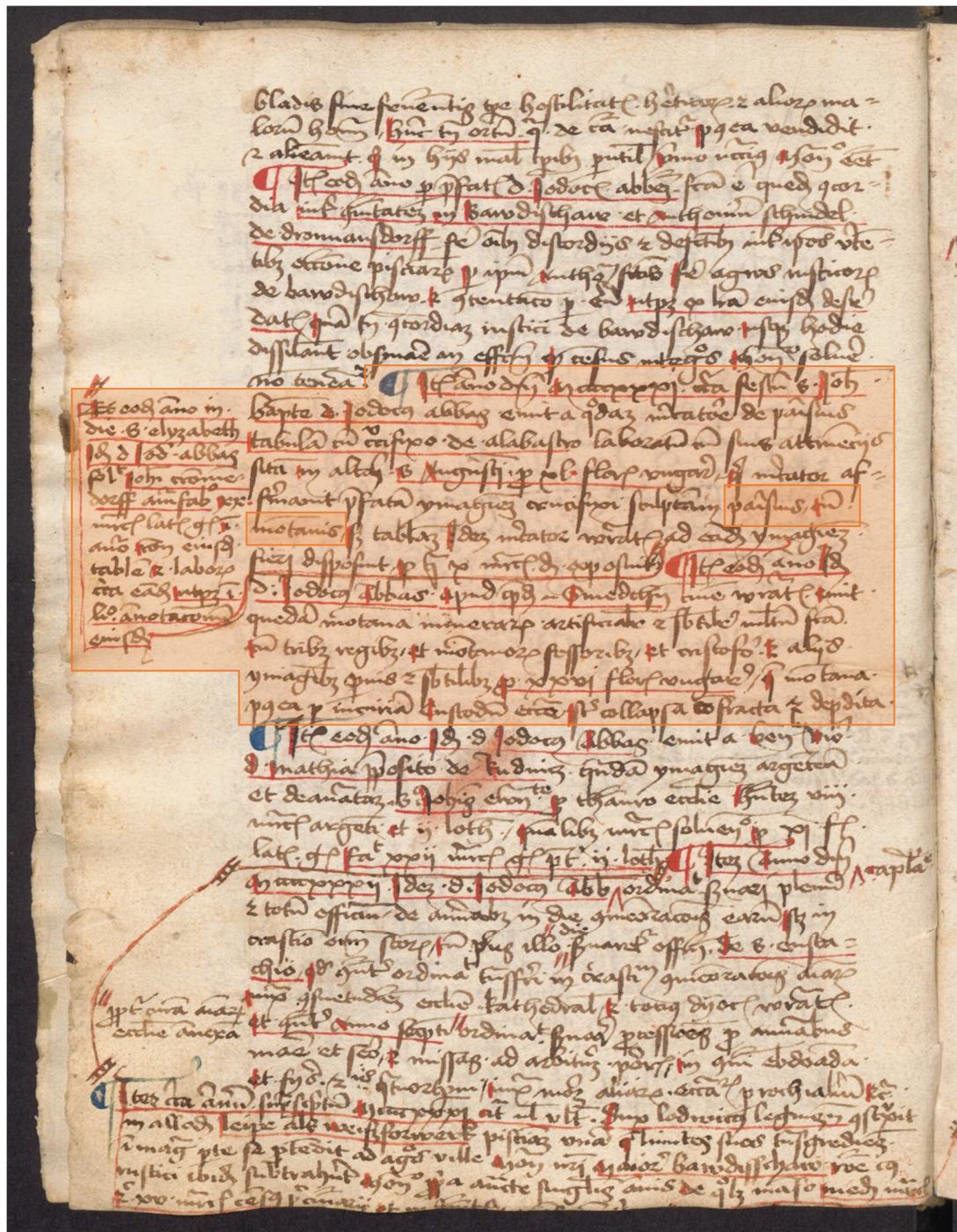
These findings imply that the passage clearly refers to a Parisian origin of the Wrocław group, the suspicious expression “*in montanis*” being identified as transcription error. Even though, the affirmation of the merchant is to be taken with precaution, as it might have been in his interest to mention Paris as prestigious centre of art production.

It further suggests that the Wrocław group was part of a Calvary and that the supporting wooden structure was delivered together with the alabaster figures whereas the corresponding shrine (*tabula*) was later produced in Wrocław. This sheds new light on the exportation and the arrangement of large alabaster ensembles as the one in Halberstadt but also the Rimini Crucifixion now conserved in Frankfurt, for which a Calvary-type arrangement could be equally envisaged.

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S1 Fig. Manuscript IV Q 205, ff. 37v-64 chart., the *Chronica abbatum Beatae Mariae virginis in Arena* from 1470, University Library of Wrocław, by the hand of Abbot Benedict Johnsdorff, successor of Jodocus Czeginhals. The passage concerning the acquisition of the alabaster Calvary in 1431 and the subsequent purchase of a group of sculptures arranged on a support in the form of mountains is highlighted. The decisive passage (double highlighted) on the origin of the alabaster group reads here “parisius cum montanis”.

Item eodem anno per presatum dominum Dodocum Abbatem facta est quaedam concordia inter communite in Bandischaw, et Antonium Schindel de Dromansdorff super iis discordis et defectibus inter ipsos etatis occasione piscinarum per ipsum Antonium factis super agris rusticorum de Bandischaw et contumio eum, ut patet ex Iris eiusdem descriptu, quam tunc concordiam rusticorum de Bandischaw usque hodie dissimilant observare in effectu quod census integres Monasterio solvere non teneatur.

Item anno domini M.ccccxxxi circa festum Sancti Joannis baptista dominus Dodocus abbas emit a quodam mercatore de parisis tabulam cum crucifixo de Alabastro laboratum cum suis attinenij sitam in altari Sancti Augustini pro XL floribus ungaricis, qui mercator affirmauit prefatam imaginem crucifixi scalptam Parisius quoniam motanis, sed tabula idem mercator Vratislauensis ad eandem imagine fieri disposuit pro qua decem marcas expogit. Et eodem anno in die Sancta Elisabetha idem dno Dodocus Abbas soluit Joanni Cromedoyff aurifabro xx marcas lat. gr. in auro ratione eiusdem tabula et laboris circa eadem, ut patet in libro annotationum eiusdem. **I**tem eodem anno Ide dno Dodocus Abbas apud quedam Smeddin ciue Vratislauensis emit quedam motana minerali artificiali et subtili multu facta cum tribus regibus, et montanorum jessoribus, et christophoro et alijs imaginibus paruis et subtilibus pro xxxvi florenis ungaricis, quae motana portea per incuria Custodum ecclesie sunt colapsa contracta et desperata. **I**tem eodem anno Idem dno Dodocus Abbas emit a Venerabili uiri dno Mattheo ppósito de Rudnicz quidam imaginem argenteam et deauratam Sancti Joannis Evangeliste pro thesauro Ecclesie habentem octo marcas argenti et duos lottones quilibet marcas soluendo pro xi ff. lat. gr. facit xxii marcas gr. ff. ij lobs. **I**tem circa annum supra scriptum M.ccccxxxi circa uel ultra dñm Lodowicū Legnicen construxit in allodium Leippe alias Weißforwerk piscinam unam quae limites suos transgredivens, in magna quantitate uel parte se protendit ad agros iulia Monasterij nri maior Bandischaw, ratione cuius rusticis ibide subtrahunt Monasterio propria auctoritate singulis annis de quolibet manso medium marcas et xv marcas censu per cuniarij, et in frumentis mensuram tritici comutavant in mejuia suenda. Et licet ipse dux ne impediretur p Monasteriu promiserit dno Dodoco abbati contentare rusticis ratione piscinam tamen nihil fecit, et licet etiam successor ipsius dng Nicolaus Abbas pluribus annis super eadem piscina egit iudicialv contra.

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cristos Ecclesia
negligens et
indifferens
caueat.

Imago debet
nisi ex arg.
de artefacto.

Parisius quoniam motanis,

S2 Fig. Manuscript IV F 200b, pp. 69-111 chart., University Library of Wrocław, a copy from 1609 of the *Chronica abbatum Beatae Mariae virginis in Arena*. The same passage as in S1 Fig. concerning the alabaster purchase is highlighted. The passage on the provenance is double highlighted.



S3 Fig. Alabaster Crucifixion mounted in a Calvary arrangement, Halberstadt Cathedral, around 1460, © Landesamt für Denkmalpflege und Archäologie Sachsen-Anhalt, Juraj Lipták

S1 Table. Analyzed artwork. Artwork attributed to the Rimini group and to Tilman Riemenschneider's workshop analysed in this study, supposed period of creation, dimensions, original situation of the artwork if known, current situation/collection and context.

Artwork	Period	Dimen-sions (cm)	Original monument/ situation	Current situation	Context/ Literature	Figure
Swoon of the Virgin group	~1430	H 46.5	Santa Maria delle Grazie church (Rimini, Italy)	Liebieghaus Skulpturensammlung, (Frankfurt, Germany) Inv. 402	Master of Rimini. Crucifixion altarpiece initially (?) in the church Santa Maria delle Grazie (Rimini, Italy) probably since its consecration in 1430, recorded since 1580 [2]. Acquired for the Liebieghaus by Swarzenski in 1913. [2, 3, 6, 7]	Fig.2A
Swoon of the Virgin	~1430	H 29, W 18, D 10	Unknown	Musée du Louvre (Paris, France), Inv. RF 1639	Master of Rimini group. Part of a crucifixion. Donation to the Louvre in 1916 [3]	Fig.2B
“Three Maries” (Swoon of the Virgin)	~1430	H 46, W 23	Church of our Lady of the Sand (Wrocław, Poland)	National Museum, (Warsaw, Poland), Inv. Śr.402	Master of Rimini group. Part of a Crucifixion acquired in 1431 for the church of our Lady of the Sand in Wrocław (Poland) by the Abbot Jodocus of the Wrocław Augustinian friary from a Parisian merchant. After the secularization of the Silesian monasteries in 1810 the group came first to the former Schlesisches Museum für Kunstgewerbe und Altertümer, Wrocław, after WWII to the National Museum in Warsaw [1, 2, 4-6],	Fig.2C
Pietà	~1450	H 48, W 41, D 14	Unknown	Rijksmuseum (Amsterdam, Netherlands), Inv. BK-NM-11667	Master of Rimini group. Donation of A. Pit, Amsterdam, 1904	Fig.2D
Pietà	First half 15 th cent.	H 26,5	Unknown	Mittelrheinmuseum (Koblenz, Germany), Inv. P 1990/13	Master of Rimini group. Acquired in 1990 from the art market (via Christie’s, London, auction April 18, 1989, from A. Neuhaus, Würzburg, Germany)[7, 8]. Virtually identical to the Pietà group in Würzburg (Museum am Dom, Cathedral), originating from Großwenkheim, north of Würzburg.	Fig.2E
Pietà	Around 1430	H 25 cm	Pfarrkirche Mariä Himmelfahrt (Großwenkheim, part of Münnerstadt, district Bad Kissingen, Germany) before 1914	Museum am Dom (Würzburg, Germany), Inv. 491	Master of Rimini group. Documented in 1914 [9] in the church of Großwenkheim, Münnerstadt (Germany) in a strongly painted version, later restored. Virtually identical to the Koblenz Pietà (Mittelrheinmuseum).	Fig.2F
Pietà	Around 1430	H 36, D 10.5	Marienkirche (former Dominican, then Teutonic church), Bad Mergentheim, Germany, before 1853 (?)	Deutschordensmuseum (Bad Mergentheim, Germany)	Loose stylistic connection to the Master of Rimini group but contemporaneous [10]. Documented in the 19 th cent. in the Dominican church (constructed in the late 14 th cent.) of Bad Mergentheim, later owned by the Teutonic Order.	Fig.2G
Apostle Saint Paul	~1430	H 44.5	Santa Maria delle Grazie church (Rimini, Italy)	Liebieghaus Skulpturensammlung, (Frankfurt, Germany) Inv. 406	Master of Rimini. Crucifixion altarpiece initially (?) in the church Santa Maria delle Grazie (Rimini, Italy) probably since its consecration in 1430, recorded since 1580[11]. Acquired for the Liebieghaus by Swarzenski in 1913 [6, 11-13]	Fig.2H
Apostle	~1430	H 46.1	Santa Maria delle Grazie church (Rimini, Italy)	Liebieghaus Skulpturensammlung, (Frankfurt, Germany) Inv. 409	Master of Rimini. Crucifixion altarpiece initially (?) in the church Santa Maria delle Grazie (Rimini, Italy) probably since its consecration in 1430, recorded since 1580[11]. Acquired for the Liebieghaus by Swarzenski in 1913 [6, 11-13]	Fig.2I
Apostle Saint Andrew	~1430	H 46.3	Santa Maria delle Grazie church (Rimini, Italy)	Liebieghaus Skulpturensammlung,	Master of Rimini. Crucifixion altarpiece initially (?) in the church Santa Maria delle Grazie (Rimini, Italy) probably since its	Fig.2J

				(Frankfurt, Germany) Inv. 417	consecration in 1430, recorded since 1580[11]. Acquired for the Liebieghaus by Swarzenski in 1913 [6, 11-13]	
Apostle Saint Peter	~1430	H 9.5 (head)	Unknown	Liebieghaus Skulpturensammlung, (Frankfurt, Germany) Inv. 418	Replacement of the head of the Saint Peter statue of the Rimini altarpiece, already headless when Swarzenski acquired the Rimini Altarpiece for the Liebieghaus. Alabaster, probably 19 th cent.	Fig.2Q
Apostle Saint Philip	~1420-1430	H 43	Unknown	J.P. Getty Museum (Los Angeles, USA), Inv. 2015.58	Master of Rimini group. Formerly collections of Ottmar Strauss, Cologne, and Oskar and Ilse Mulert, Frankfurt (Germany) acquired by the J.P. Getty Museum in 2015. [14]	Fig.2K
Apostle	~1430	H 22.9; W 8.6; D 5	Unknown; supposedly Saint-Omer Cathedral (Saint-Omer France)	Musée de l'Hôtel Sandelin (Saint-Omer, France), Inv. 2911.3	Master of Rimini group. Currently thought to have been part of an Altarpiece in the Saint-Omer Notre-Dame Cathedral, ordered in 1429 by the Canon Gauthier Ponche, similar geographic context as the lost altarpiece of the St. Vaast Abbey, Arras (1431). Donated to the museum in 1840, earlier history unknown [15, 16].	Fig.2L
Apostle	~1430	H 24.2; W 9.6; D 5.2	Unknown; supposedly Saint-Omer Cathedral (Saint-Omer France)	Musée de l'Hôtel Sandelin (Saint-Omer, France) Inv. 2911.4	Master of Rimini group. Currently thought to have been part of an Altarpiece in the Saint-Omer Notre-Dame Cathedral, ordered in 1429 by the Canon Gauthier Ponche, similar geographic context as the lost altarpiece of the St. Vaast Abbey, Arras (1431). Donated to the museum in 1840, earlier history unknown [15, 16].	Fig.2M
Apostle	~1430-40	H 39; W 16; D 10	Unknown	Musée du Louvre (Paris, France) Inv. RF 4402	Master of Rimini group (entourage). Statue of an apostolic college, integrated in an altarpiece. Acquired in 1922 on the art market. [3]	Fig.2O
Apostle	~1430	H 29, W 12 (base: H 5.5, W 9, D 8.8)	Saint Victor Church (Schwerte, Germany)	Saint Victor Church (Schwerte, Germany)	Interesting case of reuse of a series of 15 th century alabaster apostles (eight preserved) around a central enthroned Christ. They were integrated in a typical wooden carved Antwerp altarpiece, installed in 1523 in the Saint Viktor church in Schwerte (North Rhine-Westphalia, Germany), commissioned in 1521 by the Franciscan community of Dortmund (Germany). The style of the alabaster apostles is typical for the Rimini Workshop. The atypical polychromy of the apostles corresponds in style and motives to the wooden Antwerp altarpiece and dates most likely from the integration of the apostles in the wooden retable. The one century older alabaster ensemble might provide from a lost altarpiece in Schwerte or was exported together with the wooden retable (pers. comm. N. Gliesmann)	Fig.2P
Annunciation group: Virgin	~1495-1500	H 54, W 36.5, D 17	Supposedly: church of Saint Peter abbey (Erfurt, Germany)	Musée du Louvre (Paris, France), Inv. RF 1384	Tilman Riemenschneider or workshop. Supposed to have been commanded by the clergy for the church of Saint Peter abbey, Erfurt (Germany). Collection of a clergyman in Erfurt, the provost Würschmidt, in the 19 th century. Sold after 1892 from a private collection in Dieburg near Frankfurt[17-21]. The attribution to Riemenschneider dates back to 1906[20]. Achieved by the Louvre Museum in 1904.	Fig.2S
Annunciation group: Virgin	~1485-1487	H 41, W 34, D 14	Unknown	Rijksmuseum (Amsterdam, Netherlands), Inv. BK-16986-A	Early alabaster work of Tilman Riemenschneider [18, 22]. By tradition from a monastery in Bamberg (Germany) [21], acquired by the Rijksmuseum in 1960.	Fig.2T
Annunciation group: Angel	~1485-1487	H 39.5, W 28.5, D 14	Unknown	Rijksmuseum (Amsterdam, Netherlands), Inv. BK-16986-A	Early alabaster work of Tilman Riemenschneider [18, 22]. By tradition from a monastery in Bamberg (Germany) [21], acquired by the Rijksmuseum in 1960.	Fig.2U
Saint Jerome with the lion	~1490-1495	H 37.8, W 28.1, D 15.9	Supposedly: church of Saint Peter abbey (Erfurt, Germany)	Cleveland Museum of Fine Art (Ohio, USA), Inv. CMA 1946.82	Tilman Riemenschneider or workshop. Together with the Louvre Annunciation, supposed to have been commanded by the clergy for the church of Saint Peter abbey,	Fig.2V

					Erfurt (Germany). Collection of a clergyman in Erfurt, the provost Würschmidt, in the 19th century. Both statues were sold after 1892 from a private collection in Dieburg near Frankfurt[17-19, 21]. Großmann attributed the Saint Jerome to Riemenschneider in 1909 [19]. Acquired by the Cleveland Museum of Fine Art in 1946.	
Anna Selbdritt	~1515-1520	H 36	Unknown	Museum für Franken (Würzburg, Germany), Inv. ZV67983	Late work of Tilman Riemenschneider or workshop. Devotional use. Acquired by the Museum für Franken in 2006[23]	Fig.2W
Annunciation	~1520-1525	H 32.2, W 22.0	Unknown	Daniel Katz Gallery Ltd. (London, UK)	Late work of Tilman Riemenschneider or workshop. Devotional use. Formerly in a private collection in Munich, exhibited by the Bayrisches Nationalmuseum, Munich, from 1998-2002[24]	Fig. 2X

S2 Table. Analyzed historical quarries Franconian alabaster deposits and their isotopic composition.

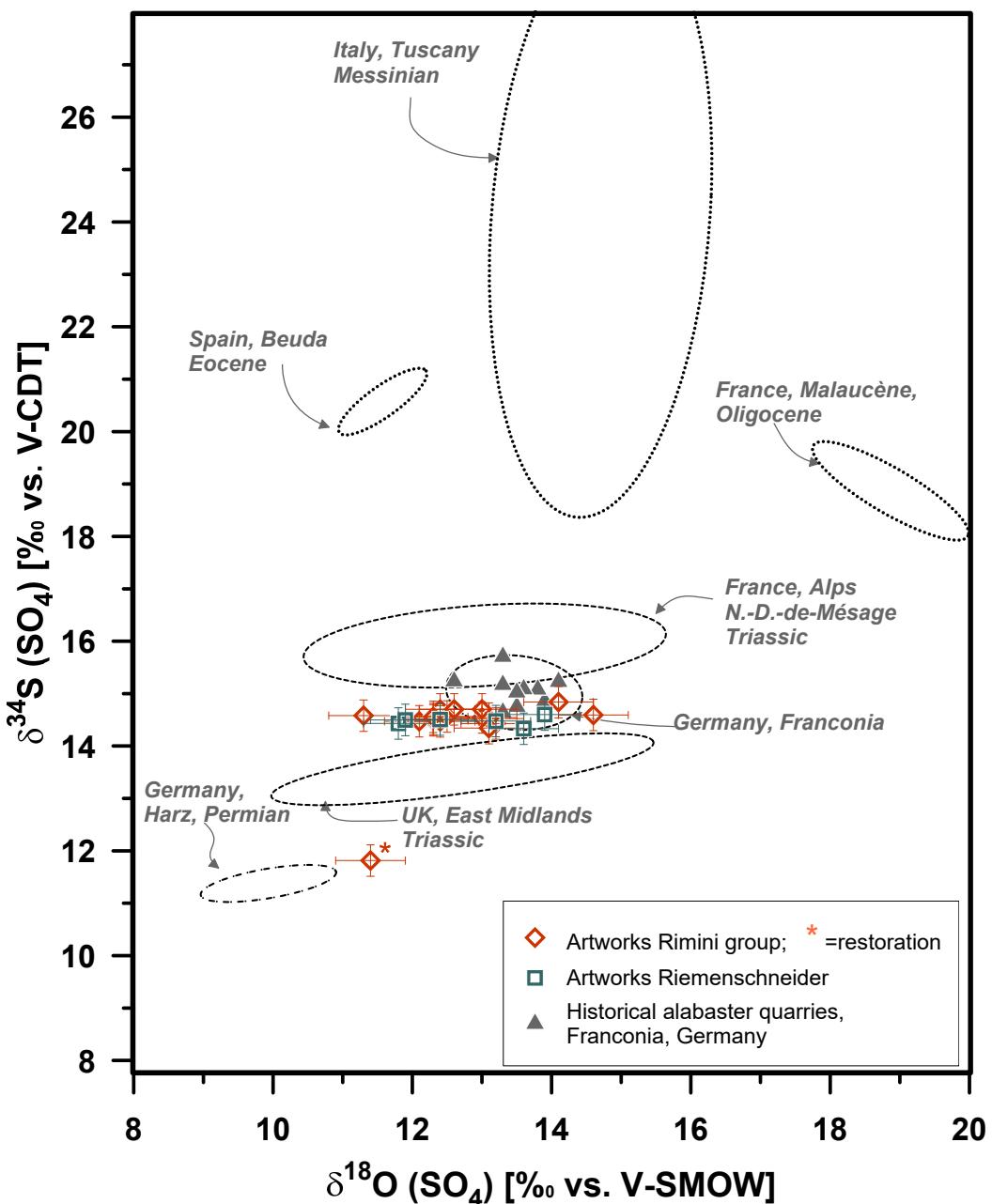
Sample	Situation	Geology	$^{87}\text{Sr}/^{86}\text{Sr}$	2σ (m) $^{87}\text{Sr}/^{86}\text{Sr}$	$\delta^{34}\text{S}$ (‰ vs. V-CDT)	$\delta^{18}\text{O}$ (‰ vs. V-SMOW)
Castell Schlossberg point 2	0.1 km S of Castell (Bavaria, Germany), vineyards	Upper Triassic, Ladinian to Karnian, local stratigraphy: Middle Keuper, uppermost part of the Myophoria beds, small nodules of slightly rose homogeneous gypsum in black marls.	0.708756	0.000009	14.8	13.5
Castell Schlossberg point 3 (2)	0.1 km S of Castell (Bavaria, Germany), vineyards	Upper Triassic, Ladinian to Karnian, local stratigraphy: Middle Keuper, upper part of the Myophoria beds, stratified greyish to white banded gypsum in black marls.	0.708535	0.000008	15.2	13.3
Castell Schlossberg point 5	0.8 km SW of Castell (Bavaria, Germany), limit vineyards-forest	Upper Triassic, Ladinian to Karnian, local stratigraphy: Middle Keuper, Estheria beds, massive greyish to white gypsum outcrop	0.708510	0.000008	14.9	13.9
Markt Seinsheim Point 1 (2)	1.5 km WSW Seinsheim (Bavaria, Germany), abandoned quarry of massive gypsum (“Grundgips”), some nodules.	Upper Triassic, Karnian, local stratigraphy: Middle Keuper, Myophoria beds, Grundgips gypsum layer	0.708599	0.000006	15.2	14.1
Markt Seinsheim Point 2 (1)	5.4 km SW Seinsheim (Bavaria, Germany), outcrop of massive to nodular gypsum, alabaster quality.	Upper Triassic, Ladinian to Karnian, local stratigraphy: Middle Keuper, Estheria beds	0.708494	0.000008	15.1	13.8
Markt Seinsheim Point 2 (4)	5.4 km SW Seinsheim (Bavaria, Germany), outcrop of massive to	Upper Triassic, Ladinian to Karnian, local stratigraphy: Middle Keuper, Estheria beds	0.708595	0.000010	15,1	13.6

	nodular gypsum, alabaster quality.					
Ickelheim Point 1 (2A)	2 km W Ickelheim (near Bad Windsheim, Bavaria, Germany), alabaster nodule, vineyards	Upper Triassic, Ladinian to Karnian, local stratigraphy: Middle Keuper, uppermost part of the Myophoria beds, nodular gypsum in black marls.	0.708649	0.000006	15.0	13.5
Ickelheim Point 3	2 km W Ickelheim (near Bad Windsheim, Bavaria, Germany), alabaster nodule, vineyards	Upper Triassic, Ladinian to Karnian, local stratigraphy: Middle Keuper, limit Myophoria beds-Estheria beds, nodular gypsum in black marls.	0.708709	0.000006	14.6	13.3
Ickelheim Point 4 "Neuer Bruch"	1.4 km WSW Ickelheim (near Bad Windsheim, Bavaria, Germany), alabaster nodule, marlstone outcrop identified as the “new quarry” mentioned by Hofmann 1757 [25]	Upper Triassic, Ladinian to Karnian, local stratigraphy: Middle Keuper, upper part of the Myophoria beds, nodular gypsum in black marls.	0.708356	0.000007	15.7	13.3
Ickelheim Point 5 (1) "Alter Bruch"	1.4 km SSW Ickelheim (near Bad Windsheim, Bavaria, Germany), alabaster fragment, weathered marlstone outcrop identified as the “old quarry” mentioned by Hofmann 1757 [25]	Upper Triassic, Ladinian to Karnian, local stratigraphy: Middle Keuper, upper part of the Myophoria beds, fragments of nodular gypsum in black marls.	0.708426	0.000007	15.2	12.6

S1 Table. Isotope signatures of artwork

Artwork	Current situation	$^{87}\text{Sr}/^{86}\text{Sr}$	$2\sigma_{^{87}\text{Sr}/^{86}\text{Sr}}$ (m)	$\delta^{34}\text{S}$ (‰ vs. V-CDT) ± 0.3 ‰	$\delta^{18}\text{O}$ (‰ vs. V-SMOW) ± 0.5 ‰
Swoon of the Virgin group	Liebieghaus Skulpturensammlung, (Frankfurt, Germany) Inv. 402	0.708603	0.000007	14.7	12.4
Swoon of the Virgin	Musée du Louvre (Paris, France), Inv. RF 1639	0.708589	0.000007	14.4	13.2
“Three Maries” (Swoon of the Virgin)	National Museum, (Warsaw, Poland), Inv. Śr.402	0.708616	0.000008	14.6	14.6
Pietà	Mittelrheinmuseum (Koblenz, Germany), Inv. P 1990/13	0.708527	0.000007	14.8	14.1
Pietà	Rijksmuseum (Amsterdam, Netherlands), Inv. BK-NM-11667	0.708635	0.000007	14.5	12.3
Pietà	Museum am Dom (Würzburg, Germany), Inv. 491	0.708605	0.000007	14.7	13
Pietà	Deutschordensmuseum (Bad Mergentheim, Germany)	0.708644	0.000007	14.7	12.6
Apostle Saint Paul	Liebieghaus Skulpturensammlung, (Frankfurt, Germany) Inv. 406	0.708658	0.000006	14.5	12.3
Apostle	Liebieghaus Skulpturensammlung, (Frankfurt, Germany) Inv. 409	0.708624	0.000007	14.6	11.3
Apostle Saint Andrew	Liebieghaus Skulpturensammlung, (Frankfurt, Germany) Inv. 417	0.708640	0.000006	14.5	12.4
Apostle Saint Peter (replaced head)	Liebieghaus Skulpturensammlung, (Frankfurt, Germany) Inv. 418	0.707111	0.000008	11.8	11.4
Apostle	Musée du Louvre (Paris, France) Inv. RF 4402	0.708630	0.000007	14.5	13.0
Apostle	Musée de l'Hôtel Sandelin (Saint-Omer, France), Inv. 2911.3	0.708675	0.000008	14.6	12.3
Apostle	Musée de l'Hôtel Sandelin (Saint-Omer, France) Inv. 2911.4	0.708638	0.000009	14.6	12.5
Apostle Saint Philip	J.P. Getty Museum (Los Angeles, USA), Inv. 2015.58	0.708648	0.000006	14.5	12.1
Apostle	Saint Victor Church (Schwerte, Germany)	0.708622	0.000008	14.5	13.1
Apostle (pedestal)	Saint Victor Church (Schwerte, Germany)	0.708642	0.000008	14.3	13.1
Annunciation group: Virgin	Musée du Louvre (Paris, France), Inv. RF 1384	0.708743	0.000009	14.3	13.6
Annunciation group: Virgin	Rijksmuseum (Amsterdam, Netherlands), Inv. BK-16986-A	0.708647	0.000007	14.5	12.4
Annunciation group: Angel	Rijksmuseum (Amsterdam, Netherlands), Inv. BK-16986-A	0.708680	0.000010	14.5	13.2

Saint Jerome with the lion	Cleveland Museum of Fine Art (Ohio, USA), Inv. CMA 1946.82	0.708608	0.000009	14.4	11.8
Anna Selbdritt	Museum für Franken (Würzburg, Germany), Inv. ZV67983	0.708728	0.000008	14.5	11.9
Annunciation	Daniel Katz Gallery Ldt. (London, UK)	0,708670	0,000006	14,6	13,9



S4 Fig. Isotope fingerprints of sulphur vs. oxygen ($\delta^{34}\text{S}$ vs. $\delta^{18}\text{O}$) of the artwork attributed to the workshops of the Rimini Master and Tilman Riemenschneider and of the alabaster quarries in Franconia (Germany). For comparison: principal deposits previously identified to have delivered alabaster for 14th to 16th century sculpture in W Europe [26, 27], $\delta^{34}\text{S}$ renormalised V-CDT.