

ATTEMPT AT RE-LOCALIZATION OF A REPORTED NORIC BONANZA

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(Dated: June 20, 2009)

Summary. As a by-product of over three decennial (intermittently done) mineralogical fieldwork on gold deposits in the Carinthian /Southern Salzburg area of Austria, guided by mining historical literature and primary sources too, attempts towards re-localization of a 2nd century B.C. Noric bonanza reported by Polybius 34,10,10–14 and this recorded in Strabo's Geographica 4,6,12 C208 are communicated. Results are cross-checked with part of the literature on the subject – palaeobotanic, linguistic and ethnographic special work been outside the paper's scope – and correlated to own (unpublished) native gold finds. Because glaciological, mineralogical/metallogenetic, geological and historical aspects in the Tauern gold context were already discussed in comprehensive monographs by Paar et al. (2000; 2006), for details is referred to these authors. In essence, not the reported bonanza's (if any) singular significance seems to have been crucial for the Noric (from 15 B.C. Noric-Roman) likely gold mining boom, but its action in drawing attention to likewise easily accessible and workable locations most contrasting to the distant small scale test or productive gold-silver mining sites along the outcrops of ore structures well above the valleys' bottom. Most of the more profitable precious metal deposits had had to be mined between around 2000 – 3000 m above sea level in the Hohe Tauern mountain area.

The paper, its 2008 version judged “not of sufficient relevance to readers of the Mining History Journal” (US) and the current one expectedly not accepted for publication by the Editorial Board of the Oxford Journal of Archaeology (UK), but the data given nevertheless maybe of interest to specialists, so was published online.

To CILLI DAVID and LOIS DAVID sen., meritorious Salzburg-Carinthian minerals collectors,
in memoriam.

INTRODUCTION

Referring to the brilliant Greek historian Polybius (hist. XXXIV, 10, 10–14), the imperial Roman age geographer Strabo (geogr. IV, 6, 12 C208) reports the (when cited well over 100 years old, *remark by F.J.C*) message about the discovery of an exceptionally rich gold mine in the tribal area of the Norici (Taurisci):

“ Ἐπεὶ φησι Πολύβιος ἐφ' ἑαυτῶν κατ' Ἀκυληϊαν μάλιστα, ἐν τοῖς Ταυρίσκοις τοῖς Νωρικοῖς, εὐρεθῆναι χρυσεῖον οὕτως εὐφυές, ὥστ' ἐπὶ δύο πόδας ἀποσύραντι τὴν ἐπιπολῆς γῆν, εὐθὺς ὀρυκτὸν εὐρίσκεσθαι χρυσόν· τὸ δ' ὄρυγμα μὴ πλειόνων ὑπάρχειν ἢ πεντεκαίδεκα ποδῶν· εἶναι δὲ τοῦ χρυσοῦ τὸν μὲν αὐτόθεν καθαρὸν, κυάμου μέγεθος ἢ θερμού, τοῦ ὀγδόου μέρους μόνον ἀφεψηθέντος, τὸν δὲ δεῖσθαι μὲν χωνείας πλείονος, σφόδρα δὲ λυσιτελοῦς...” (editio stereotypa Car.Tauchnitii 1819; Arial/Unicode MS,Tahoma; Greek).

“Praeterea Polybius autor est, sua aetate apud Aquileiam, et in Tauriscis praecipue in Noricis, auri solum ita ferax repertum, ut exhausta duum pedum altitudine terra, statim occurreret aurum fossile, fossam autem quindecim pedes non excessisse; aurum partim statim purum exstitisse, fabae aut lupini quantitate, octava tantum parte decocta; aliud maiori quidem diffusione indiguisse, sed ea admodum utili...” (Greek passages cit. omitted, from Muchar 1821, Prof. A. Muchar been an Admont Benedictine monastery’s former librarian/old languages expert).

Polybius/Strabo’s frequently cited passage – Tauchnitius’ version been a source for Muchar’s (1821) statements on the subject used later on, the passage cited here just slightly differing from the analogous text of Strabo’s *Geographica* edition by Radt (2002, 548) – allows for a variety of translations, (mis)interpretations and misunderstandings too. One of these is the topographic/ethnographic detail ἐν τοῖς Ταυρίσκοις τοῖς Νωρικοῖς (gold-finds’ location “with the Noric Taurisci”), almost without exceptions been misunderstood as shown by Graßl (2000) via in-depth comparison of this passage with Greek and Roman authors’ practice of ethnologic terminology: Thus, an asyndetic compound name, mentioning branch- and main-tribe given (Taurisci been referred to by Polybius four times in total, attributed to different regions in the Alps, i.e. the main tribe), and an ethnonym’s adjectival use as specification of an other (nominal) ethnonym been unknown in the old languages, Polybius clearly locates the gold finds reported to within Norici’s tribal area. By emphasizing the Taurisci component, and the reported gold finds been unexpected /sensational, thus attributable to exotic locations too, Šašel Kos (1998) suggests a location in the Poetovio region /Slovenia, Tauriscan area in those days (thus maybe a Tauriscan – Roman joint operation). And she closes her publication (ibid. 219) with the conclusion that “no event related to the Taurisci, whether they are called the Norican Taurisci or not, could be ascribed to the Noricans in Carinthia”.

Divergence exists on mines’ sites in translation: while H.L. Jones’ one from Greek (Jones 1923a) says “there was found, about opposite Aquileia in the country of the Noric Taurisci, a gold mine so well-suited...”, there are a few German versions (e.g. Muchar’s 1821, Wießner’s 1950) stressing locations near Aquileia *and* particularly with the (Noric) Taurisci/Norici, again allowing for search in Carinthia /Southern Austria too. In Kärcher’s geogr. translation into German (Kärcher 1831) Polybius says that in his time *mainly near Aquileia* so plentiful gold was found...(Kärcher omitting the ἐν τοῖς Ταυρίσκοις τοῖς Νωρικοῖς detail, possibly been unable to properly interpret this). From the mid /end - 2nd century B.C. on, all of the Noric kingdom’s residents were called Norici by the Romans whose usage was later followed by the Greeks (Heuberger 1954, 170; p.168 ref. to the archaeologist R. Egger’s understanding of Polybius’ Noric Taurisci, these seen as the Celtic residents of the major part of Carinthia). A “Noric Taurisci” - topic’s sources and literature critique is given by Haider (1993). Before going into detail, the likely economic impact (if any, Gleirscher 2009, 89, Polybius’ text on a major but hardly significant in the long term deposit) by the praised mines’ gold production told later in Strabo’s quote and then claimed to have reduced the gold price by one third throughout the whole of Italy awaits assessment. While Polybius’ news fit Roman economic/military strategy and are either respectfully transported (e.g. by Muchar 1821, Rochata 1878, Pogatschnigg 1900,

Davies 1935, Preuss 1939, Wießner 1950, Gmelins Handbuch Gold 1 1950, 24; Alföldy 1974, Šašel 1974/75, Eibner 1985, Šašel Kos 1998, Strobel 2003), or taken no notice of (in “Geschichte Kärntens” by Fräss-Ehrfeld 1984, the 2nd century B.C. gold finds possibly not correlated to Carinthia by her), there is sporadic doubt about too (e.g. by Kahler 1974 /75, 113; Gleirscher 2009). Kahler’s view with weight from both, firm classical education and expertise as a Land Carinthia’s former chief geologist, is this: the report might point towards sensational news in ancient Rome, these maybe knowingly exaggerated by speculators, and so possibly indeed having induced a sharp fall in price (Gleirscher 2009, 88 concerning this thinks that the mere news of an undoubtedly remarkable gold find may have driven rumours/fears to this path, or the capital market, respectively). But it is quite unlikely that the large Roman gold market could have been influenced in a way to make metal price sink by one third. For that it probably was much too strong. Logically, Kahler rather thinks of the beans-size (fabae quantitate) nuggets news’ shrinking to single finds, the residual core of the message quite likely proving that in the Tauriscan area gold was produced in Polybius’ time (so Homann 1985, just deducing reliable Celtic gold recovery from 130 B.C. on as far as present-day Austria is concerned) and found its way to Rome. Thus Kahler turns out to be a most unsuspecting witness for deposits’ details needed later on. Background studies (Paschinger 1976 et lit. cit.) perceive Polybius’ report been about Tauern gold mines and gold-“washings” (these near to Drau river and in the upper Lavant Valley /Lower Carinthia). A long tradition of the Celtic Alpine gold recovery from gold sands of the rivers and torrents is evident (Muchar 1821, 16 for that there quoting Posidonius in Athenaeus /Dipnosophistae VI on (Helvetian) gold-washing saying that this essentially was the work of Celtic women and old men). And Strabo 4, 6,12, referring to the time when the Romans already were in possession of the Noric gold mines, in Jones’ (1923a) translation says “... and here, too, just as in Iberia, in addition to the dug-gold, gold-dust is brought down by the rivers – not, however, in such quantities as there.”

BONANZA’S (IF ANY) LIKELY LOCATION

The Protestant preacher and historiographer Michael G. Christalnick (his “Historia Carinthiaca” finished in 1588) mentions and also localizes Polybius’ message (Neumann 1999, 85), claiming that of this “*erzgrueben warzaichen man auch noch heutigs tages unterhalb Villach sichtet auf der seiten, da man ins Welischland ziehet*” meaning that the ore-mine’s signs still be visible these days below Villach, on the side where one roves to Italy. Linking antiquity’s prominent sources to Carinthia fitted local humanists’ historicism. The location problem, i.e. that Polybius’ report possibly refers to the Tauern massif, is an open task (Gruber 2006, 189f.) in view of an unlikely Taurisci ↔ Tauern names relation or the unsettled tribe-localization, and evidence sensu stricto for Tauern gold mining even in Roman times still being missing. In line with Graßl’s (2000) work and Piccottini’s (2001) remark on “event’s” site – most likely on present-day Carinthian soil – solution comes by stressing the praecipue-in-Noricis passage. Wießner (1950, 33), Carinthia’s master of its mining history, calls the goldmine’s localization within the Hohe Tauern or their peripheral areas a justified assumption. Gmelins Handbuch der anorgan. Chemie, Gold Lfg.1 (1950, 24) correlates the cited text of Strabo’s Geographica to major gold finds in Carinthia, no conclusive evidence offered. In a local, because of the Waschgang gold deposit /Zirknitz Valley, Upper Carinthia historically significant context, the cited passage is used for “safe” dating of settlement in the upper Möll Valley 150 B.C. (Lindsberger undated, 3), likely for

projection toward a start of large scale Roman mining activity in Tauern's Goldberg group too (ib.4). Citing a compilation of Roman authors' reports on Eastern Alpine gold recovery (=Muchar 1821), Canaval (1888, 15fn.) finds it very questionable where the passage from Polybius in Strabo therein is to be correlated to, since in addition to the numerous mines working original (i.e. enriched primary) ore deposits, placer works were operating in many locations within Carinthia alone. Muchar himself (1821, 16fn.a)) stresses that Polybius' message need not be understood in the usual mining context only, but also and specially in connection with ancient placer works, and tends to locate the Tauriscan goldmines in the mountain regions of the upper Möll Valley /Carinthia and of Salzburg's Pongau area (latter region's first mention as <in Bongouue> in 924 A.D.). Pon-gau composite name's etymology is not entirely clear, but the defining component quite probably relatable to Celtic *bona*, meaning residential place (Pohl 2009, 108 et lit.cit.).

Extrapolation from ancient messages is a subtle business as is true of Muchar's (1834) likely lucky one, his statements decreasingly contrasting to work by Heger (1974) and Gruber (2006, 243ff.) in the still open Salzburg Roman gold mining context: e.g. his claimed operation of Tauriscan Gastein and Rauris mines by the Romans, step by step dismissal of Tauriscan miners..., no evidence given, but meanwhile Roman age artefacts are proven near to Bockhart Valley's ore structures (Lippert 1999 et cit.), and there likely indeed was (Noric-)Roman gold mining from Gruber's indications. Preuss (1939, 51 and lit.cit.) states that Tauriscan gold mining was actually shifted to the Tauern area only for onomastics' reasons (with just weak support) and because of medieval mining there. So, in line with Davies (1935), a bonanza's location somewhere in the Tauern region/centre of the Noric kingdom became more or less common opinion in scholarly literature. In a paper on Taurisci and Norici (Heuberger 1954, 162) the gold finds according to Polybius' XXXIV,10,10–14 message are attributed to the Upper Carinthian Drau region referring to Brunner (1940, 143 saying that the gold finds' unknown location should presumably be looked for in Carinthia, Brunner cit. Polaschek 1936a, 1042f., a review of Noric economy /mining and archaeological data suggesting a Roman age imperial mines administration centre in Lower Carinthia, the Romans quite possibly having taken over the mines from the Noric kings), Egger (1941, 9) and Miltner (1941, 298). In more detail, the target area extends along Drau river from Möll river's junction downstream and along Möll river itself, including its tributaries. This localization is argued with Aquileia's proximity, and with the (too qualifying, *remarks by F.J.C.*) conclusion (from just Goldberg group's mines of the Hohe Tauern goldfield been listed by Kieslinger 1940, distant locations in schist facies or others not treated there on purpose) that within Southern Noricum only watercourses running off the Goldberg group /Möll Valley carry amounts of gold worth mentioning. Miltner (1941, 298, here restricting the search area to Western Carinthia, namely the Drau region, citing Kieslinger 1940 and Brunner 1940) for some obscure reason tells of Eastern Carinthian gold deposits' (and on p.294 also of Gail Valley's gold's and iron's) absence too. Brunner (1940, 143 and lit.cit.) says that while there is evidence of Eastern Alpine copper and salt mines from Bronze Age on, and "Noric" iron was produced since the Hallstatt period ..., there seems to have been no (primary) gold mining or none worth mentioning after all, whereas Muchar (1821, 18) speaks of ancient "tauriszischen Goldschachten" (g.-shafts). The one of Taurisci's alpine mining regions nearest to Aquileia been located in the upper Gail Valley /Southwestern Carinthia and even connected to this centre by the much-used elder Plöcken road, Pogatschnigg (1900, 33) thinks that one should hardly go wrong by relating Strabo's gold-finds-near-Aquileia message to this area. He further speaks about

a Dolling /Würmlach goldmine in this ancient Venetian/Celtic/Roman mining area (mining “dated” by ancient roads in local gold /iron deposits’ proximity). Dobesch (1980, 237f.) – Strabo 4, 6,12 ’s target(s) within (South)eastern Alps – in the quote’s < after the Itali had been working together with the natives...> context adds an interpretation stressing Itali’s superior mining experience: if the Itali were given a share in a this easily exploitable gold deposit at all, this just should mean that they found it. They quite possibly should have participated in discovery of new deposits elsewhere. Strobel (2003, 60f.), the mine’s type interpreted as working of a secondarily enriched coarse-grain native gold bearing primary deposit by him, refers to such Au-deposits in the so-called Tauern Window (and mentions further in the Kreuzeck-Goldeck group and Saualpe/Kliening too). Gleirscher (2009, 88f.) offers multiple choice in site of the gold mine, this worked without major logistic effort and attributable to the (primary) Waschgang/Zirknitz and Kliening /Lavant Valley deposits as well as to Weißenbach /Paternion area’s placers. The localization of Polybius/Strabo’s message – the sites suggested just been a subset of offers – faces a major problem: a text passage preserved without context. There is a gap in geogr. 4, 6 right before.

Although the reported Noric goldmine’s *real location* is not derivable from Strabo’s quote, there is a quite complex way for constraining its likely site or type, in all probability. Relying on Polybius’ known precision, details of his text can provide powerful arguments (such analysis, sentence by sentence in Šašel Kos’ 1998 paper and lit.cit.). Native gold’s reported grain sizes of fabaceae family’s beans scale, specifically of genisteae (lupinus) and viciaeae (vicia sp.: vicia faba, till Roman age’s end only the small-seed form proven for Europe, Pawlik 1992 et lit. cit., its Ancient Greek name been κύαμος – etymological /linguistic details in Fischer 1992 et lit.cit.) safely exclude the predominance of fine grain fractions, whereas form should exclude irregular-(mean)-shape thin up to massive grain. Shape axiom’s validity is an issue later on in the variant translations from Greek context. There is some elasticity in reported gold grain sizes’ perception: i) “Wolfsbohne”(= lupine bean) size only (Aelschker 1885, 81), ii) “Sau- oder Feigbohne” (vicia faba or lupinus) sizes (Gmelin Handbuch Au1 1950, 24, cit.), or in other words, “gemeine (field bean) und Wolfsbohne” sizes (Muchar 1821, 15), iii) bean or lupine sizes (Strabo’s geographica translations by Kärcher 1831, 391, Jones 1923a, 293 and Radt 2002, 549; Wießner 1950, 32 too) and iv) bean size only (Pogatschnigg 1900, 33). Polybius’ intention to express gold’s typical grain size range in common terms so recommends a coarse-grain condition /axiom in site-search (lupine size already had met Kahler’s 1975, 113 view).

Reported deposit’s thickness plus 2 ft. of soil (total 15 ft., fossam autem quindecim pedes non excessisse...), can be interpreted as surface to (bed)rock or any other limiting barren layer levels’- difference in all probability. This forces a “stratiform” character, quite like Šašel Kos’ 1998 understanding of Polybius’ description as that of an alluvial deposit or alluvial terraces well above present-day riverbed-levels feigning primary deposits (ref. to Täckholm 1937, 26 and Eibner 1985, part of her information by M. Bidovec /L. Placer), and the absence of deposit’s continuation in ores vertically underground. So, locations in weathering and oxidized zones right upon the orebodies of the famous later underground or open pit gold mining sites violated this constraint. Next, eluvial/deluvial placers (if any) originating from these orebodies lose all credibility if gold’s transport distance is unlikely to allow for a mean-shape transition from irregular to roughly plated ellipsoidal grain (if not starting from already ± regular primary grain, a most unlikely situation for grain size’s range reported). As reliably in situ re-grown Carinthian /Southern Salzburg alluvial gold

was never observed by author's microscopic check of the native gold panned, shaping is largely mechanical. On the contrary, efficient downsizing (such even active with massive platelets) was detected, part(s) of the platelet bent over and finally separated after edges' squeezing/abrasion. From the passage on (initially lacking?) usage/smelting of the (later) obviously profitably melted co-recovered, auriferous major material fraction (*aliud maiori quidem diffusionem indiguisset, sed ea admodum utili*) the ores' nature should be traceable. Pyrite/arsenopyrite gold and not too fine-grained quartz-veins gold had been extracted in the Norici's traditional way of Tauern(?) ores' processing /smelting. That the problems, if any, turned out to be ± satisfactory solvable, likely by crucial smelting know-how transfer (Romans *later* in general not been innovative in metallurgy, Šašel Kos 1998 cit. Täckholm 1937, 16–17, but Veneti's smelting tradition underrated by her analogy to the imperial age state) within an unspecified help context as stated later in Polybius' message, indicates chemical rather than thermal barriers. Latter had been surmountable by native specialists leading in ferrum Noricum metallurgy (an early review of ancient authors' praise of Noric steel given by Muchar 1821 ch.26). Auriferous (pyrite-)chalcopyrite ore could fit the Celtic smelting troubles – copper/matte largely collecting the precious metals, competing with extraction by lead (if such in the melting process) and enhancing the extraction problems with increasing liquid copper fraction (G. Sperl, private communication 2007). Excessive use of lead /moderate heat /additions for thinning out the Cu content too, simultaneously benefiting from gold's siderophile nature, maybe worked (a process, more sophisticated /lengthier as usual, needing “a good deal of smelting”). Metallurgists in Veneti's tradition are believed to have been capable of such complex technique (by author's view), since Pogatschnigg's (1900, 31/32) list of the local ore minerals indeed contains chalcopyrite (such been gold-bearing in several sites) among the alluvial drift of the Kreesbach- and Kronhofgraben, both situated on shady side of the upper Gail Valley, an ancient mining region. Gleirscher (2009, 87) correctly says that Polybius' information does not explain whether the operation was handled with Roman technology, and property/profit aspects remain open too.

The mining historical conclusion from Strabo's quotation that the gold ores were smelted by the Taurisci, but in a most superficial and over-exploitative manner until been helped by the Itali (Wießner 1950, 33, transported by F.J.C. when summarizing extracts from statements by Wießner 1950, Lindsberger (undated) and Ertl 1981 for a non-expert reader Tauern gold essay 1982) entirely fails to meet natives' praised metallurgical skills. H. Wießner bases his allegation on Strabo's geogr. 4, 6, 12 text module (its Latin version being) ...aurum partim statim purum exstitisse, fabae aut lupini quantitate, octava tantum parte decocta, the latter sequence's translation into German used saying that only 1/8 (of the ores) was found to be worth melting (the text following misinterpreted too, the major part considered unworthy of smelting, possibly by *indiguisset/indignisse* mistake). Muchar (1821, 15) speaks of that good quality and pure gold (if true, the statement forced a high-grade aggravation of the gold's grain size condition in location search), his version saying ...not quite one eighth was lost in melting. Jones' (1923a) translation in this context says that “part of the gold is immediately pure, in sizes of a bean or a lupine, when only the eighth part is boiled away, and that although the rest needs more smelting, the smelting is very profitable.” This wording should anticipate Norici's smelting state-of-the-art *after* been helped by the Itali, so omitting the time when the majority of ore material recovered maybe indeed proved non-usable for technical reasons (though profitably smelted later). Native gold's treatment, if faithfully reproduced, as well as (weight) loss indeed remind of

ancient gold refining in a cementation process, a view also expressed e.g. by Šašel Kos (1998, 218, citing information by A. Paulin), salt most likely been the mid-2nd century B.C. Tauriscan and Italian metallurgists' additive. Gold, refined by means of a sort of styptic earth (containing alum and vitriol, Jones 1923b), not given any additional process details is reported by Strabo, geogr. 3, 2, 8 (survey of ancient gold mining/refining in Gmelin Au Lfg.1 1950, Strabo on Noric and Gallic practice ib. 24 and 28). In W.R. Paton's translation of Polybius' Histories 34, 10, 10–14 fragment the gold from the mine discovered "not far from Aquileia in the country of the Noric Taurisci" consisted "partly of nuggets as big as a bean or a lupine, which were pure gold when the eighth part only had been smelted off, and partly of stuff which required a good deal of smelting but was very rich...". By this interpretation, cementation seemed less stringent, but nevertheless remained an option. Same is true of Radt's (2002) translation of Strabo's 4, 6,12 passage into German, this in the process' context approximately saying that ...the gold in parts was pure of its own accord, as large as a bean or a lupine seed and gave just one eighth loss in melting-off... Polybius' statement concerning the metric details of the mine would not be applicable to inclined terrain without extra remarks, so its location had to be more or less flat ground. The mine's extraordinary and quick productiveness, remarked by Dobesch (1980, 236f.), likely required substantial manpower and area, latter criterion hardly met by alpine sites. The occurrence of an exceptionally rich placer gold deposit fitting the details of Polybius' message additionally required sufficient transport flow, i.e. a larger river, distinct velocity gradients for efficient separation processes (Baumann, Nikolskij and Wolf 1979 and cit.), a stable course and an almost invariable bedrock geometry /anomaly for extra long time, thus safely excluding locations along torrents.

ATTEMPT AT LOCATIONS' AXIOMATIC ELIMINATION

Equipped with constraining conditions, mining historical detail data got from later production periods and experience from own prospecting work (profiting from know-how transfer by the British gold prospector Alf Henderson, Windermere /Cumbria), the search for Noric gold deposit's unknown location within Carinthia – and sporadically in Southern Salzburg – shall be handled by a sites' elimination procedure (from famous/legendary to seldom quoted):

✘ **Waschgang /Zirknitz Valley:** The site is described as one of the oldest, once richest mines in Upper Carinthia (maybe dating back to Roman period), with a large native gold fraction of the ore material, the gold then up to hazelnut size and platelets of up to 2 cm (Rochata 1878, 282; for geochemical and /or ore mineralogical details see: Paar 1981, Paar and Chen 1982, Horsch 1989, Paar 2006; for history: Wießner 1950, Gruber 2006). Visible gold is predominantly irregular shaped, also true of larger grains usually enclosed in carbonate matrix, such grain of 48 mg wt. found by panning Rosina Adit's residual ore material (Culetto 1983, unpublished). Location's name as well as Rochata's statement on Waschgang gold's grain size remind Gruber (2006, 339) of Strabo's famous quotation, and he sees an analogy to alpine placers in the highest Rauris Valley/Southern Salzburg. But the Waschgang deposit of metamorphogenic origin, with metals' remobilization and reconcentration in fault structure (its rich native gold/chalcopyrite mineralization restricted to a fault; for geological details see Prey 1964, Litscher and Riedmüller 1980), can be excluded axiomatically: A site upon deposit's orebody (by Rochata's 1878 map's vertical

cross section no outcrops where terrain had been flat, none of the orebody's rich sections located near to the surface, from his data p.281-287) is ruled out; the only ± flat area for an eluvial/deluvial placer is 100 - 200 m downhill, thus violating the form transition axiom. The high-grade aggravation (if such is the case) of the grain size axiom is unlikely met by Waschgang native gold's average fineness (data range by Paar 2006, 180; own results by panning Mathias- and Rosina Adits' old ores, electrum colour grains frequently seen). No water course is present apart from thaw, and heavy showers had generated torrent-like effects. Massive auriferous chalcopyrite/pyrite in carbonate/quartz/prasinite matrix, together with small magnetite xx (=crystals) fit the criterion and had led to gold extraction problems in the auriferous copper context. Exaggerated richness is claimed of the site and the mining rights occasionally were objects of wild speculation (Kahler 1975, 109).

✂ **Strabaleben mine** /*Wurten Valley (on Salzburg's side of the mountain range)*: One of the Strabaleben ore-veins, once mined beyond Carinthia's border to Salzburg, is said to have been unique (by Salzburg /Carinthian gold diggers) and fantastically rich, with up to 4 – 5% “good gold” content (Rochata 1878, 293). In strongly inclined terrain (next to, or covered by glacier) a vein with bluish loamy filling was mined, so rich in native gold that the diggers even used to carry away muddy material from adit's floor if they were unable to progress through the ice toward the level's face. Thus, a significant fraction of the gold recovered had to be fine-grained. Apart from the bonanza character (which is doubted to a certain degree by Rochata, and only the location's ochre or loamy vein material called “Goldlasur” is mentioned by Gruber 2006, 338), this judged not overdrawn by Paar (2006, 89) due to mechanical and/or chemical enrichment processes in the outcropping parts of gold-ore bearing structures, the location fulfilled none of the axioms formulated above. Expectedly, no analogue of the legendary veins (for completeness' sake, one with brown “Goldlasur” is spoken of in Rochata 1878, 294 too) could be traced on these structures' Carinthian side by own (modest) search, there been off Hohe Tauern national park area. For Carinthian-side Strabaleben mine's ore mineralogy /analyses see Paar (2006, 89). A Strabaleben ↔ Strabo names correlation(?) – the toponym sounds “Strabolebm” in local dialect – is not really supported by place's synonyms: *Strabeleben* (Paar 2006,89; Gruber 2006, 338; Rochata 1878, app., in his map of Tauern chain's ore-bearing veins beside Strabaleben; Waldmann 1940, 156, Strabeleben once possibly been a plain far below the glacier field and named so after Strabel, its owner), *Strabbeleben* (Feitzinger 1992, 25 and lit. cit.) and also *Strappeleben Sp.* (Spitz(e) = mountain peak), a nearby peak of same name (KOMPASS Wanderkarte 49, Mallnitz-Obervellach). As a full half of selected older Carinthian mountain names belongs to wild demons' and mysterious cults' sphere (Kranzmayer 1950, 611), any legend-attached etymology is not unlikely if toponym's age indeed was much older than thought of in Waldmann's remark.

✂ **Goldzeche** /*Kleine Fleiß Valley*: The mines complex between approx. 2600 – 2900 m above sea level (glaciers' status had favoured mining there before and during the Roman climatic optimum, Slupetzky 2006 and lit. cit.) is reported to have been the most extended and correspondingly profitable of the Carinthian Tauern area's gold mines, going back to Tauriscan and Roman ages (Rochata 1878, 246). According to Rochata (1878), Pošepný (1880), the main vein and two footwall fissures (further three hangingwall veins present but ± unworked; all structures of Tauern gold vein type, mineralization /metallogenesis in Robl and Paar 1994, Robl 1996 and Paar 2006) were mined. Sporadic bonanza-scale gold contents, 0.2%, are reported for ore residues (Rochata 1878, 258), the native gold

on average over the Goldzeche complex having been of 0.5 – 2 mm and more grain size. Gold grains $\geq 0.1\text{mm}$, a “xenomorphic” one of 1.5 x 2.5 mm size apparently shaped by its drusy matrix’ quartz xx planes, were extracted by panning so-called “ockrige Pochgänge” - material (= ochre drusy quartz containing decomposed sulphosalts, native gold, residual sulphides) from Anna Adit’s old ore reserves (Culetto 1983, unpublished). The location is unable to fulfil the grain size demand (as many of the deposits belonging to Tauern gold vein type) in all probability, and its likely oldest, uppermost mining site called “Fundgrube” (2925m above s.l.) additionally violated the no-mining-upon-orebody and flat-area axioms (there is no two feet of soil in this height too). Alpine placers along the Kleine Fleiß Valley (if any had \pm fulfilled the criteria), originating from the location’s former orebodies, all had suffered from damaging torrents. Loss from stamp-milling of native gold bearing material from Fleiß Valley’s former mines still is detectable in the Alter Pocher and Mühlgraben /Heiligenblut locations (former with a Tauern goldmine-village museum showing all of the historical process’ steps and miners’ living /work, Stüber and Winding 2005, in both sites tourism gold panning), then further downhill along the Fleiß brook and finally along Möll river. There, rare native gold grains up to a few tenths of a millimetre and also sub-mm platelets were detected by panning (Culetto, unpublished), far off coarse grain condition’s lower bound in all of the sites probed. So, the view of Möll Valley being target to Polybius’ message as defended by Heuberger (1954 et lit. cit.) is quite unlikely to get support from fieldwork. Former placer gold recovery along the Möll river is reported by Wöllner (1820, 114), Riedl (1873, 2, it seen as the final manipulation of an imperfectly done processing, generalizing Wöllner’s view of ancestors’ lousy stamp-milling/sliming), Canaval (1888, 15 by mines industrialist v.Gersheim), Schöppe (1950), Zirkl (1982) and Günther (2006, 523 mentioning natural, processing-losses-enhanced precious metal contents of gravels and sands of the watercourses in the uppermost Möll Valley’s Döllach and Heiligenblut area). Latter site’s historical secondary gold recovery is also mentioned by Wießner (1950, 132 cit. loss of almost half the metal content when processing Goldzeche’s ore). The ancient, having mined the so-called “Liegendkluff” too (footwall fissure’s richness and large area still unworked reported by Wöllner 1820, 110), should have concentrated on native gold bearing stuff’s recovery as the ores’ processing was very difficult at the smelting state-of-the-art in those days due to considerable copper content (Canaval 1907, 71f.).

Having axiomatically eliminated the famous Carinthian Tauern gold mining sites, Noric bonanza’s likely location further shall be looked for among the famous peripheral (mainly placer) gold deposits, fitting Muchar’s (1821, 16fn) understanding of the message as well as Aelschker’s (1885, 81 and Polybius’ report seen likely correlated to the Tauern slope’s alluvial land). Aside countless small(er) placer gold mining sites, there were two Carinthian locations of native gold in gravels which are reported to have been extensively exploited (the area of the Lavant Valley’s one in Lower Carinthia tachymetrically recorded and described in a placer mining-archaeological manner by Friedrich 1958):

✘ **Wiesenau placer works** /Lavant Valley: Unexpectedly, residues of extended placer gold mining activity were re-discovered in late 1956 in search of gravels suitable for road construction, with focus on the flat alluvial cone situated in front of the Klieninggraben’s join with the Lavant Valley (Kahler 1975, 113f.). Totally worked-through gravels, partly agglomerated to walls were found, the usual fine grains fraction almost entirely missing. Soon after, worked marble stones from rich Roman burial monuments showed up, these been carelessly removed in order to exploit the gold gravels below, then backfilled and

covered with overburden. Kahler stresses that the mined placer area is large, but there is no message on production /direction of this apparently very systematically done recovery (apart from a report on the site's small scale operation in 1757, Hermann 1832, 74, this cited by Canaval 1895, who also confirms the once most extended placer mining). Kahler excludes the Wiesenau placer as target to Strabo's message since the Roman age burial monuments (2nd - 3rd century A.D. artefacts' archaeological details in Dolenz 1959) were erected later /even later wrecked. He adds that the Tragin placer deposit/Paternion, Drau Valley sooner was a possibility. Before changing the site, an annotation is overdue: In the Klieninggraben, within/nearby village **Kliening**, there is a famous old gold mines complex (mining history in Hermann 1832, Wießner 1950, ch.IV.5.; deposit's details in Sterk 1955) where, when adding up all the mining activities along the valley, the largest amount of gold and silver in Carinthia is said to have been produced (Riedl 1873). The ore material, essentially gold-bearing arsenopyrite/pyrite, auriferous löllingite (the ancients' preferred ore as told in Riedl's 1873 report, but löllingite's importance doubted by Sterk 1955, 42), galena and native gold in predominant quartz matrix needed stamp-milling (processing loss still detectable by panning: ±dull native gold ranging from around 0.1 mm grain size up to rare larger irregular shape grains too, such with 54 mg and 57 mg found in 1995 by the author, unpublished). In the Klagenfurt mining museum's 1981 "Goldland Kärnten"-exhibition context, a secondary gold sample was gathered by panning material of along the Kliening brook (G. Finding *et al.*, private communication). Plentiful native gold in a few special quartz samples and also secondarily enriched, chloritic specimens containing a lot of gold grains side by side up to 1 mm in size, are reported by Sterk (1955), who also mentions Kliening deposit's oxidation /cementation zones. Early 16th century gold from the Lavant Valley, no details on location(s) or native gold's grain size told, is described by the famous iatro-chemist Paracelsus. His "Chronica und ursprung dieses landts Kärnten" (1538, published posthumous within the Byrckmann edition of his "Drey Bücher"/Cologne 1564; Goldammer 1955, Moro 1955a,1955b; for more recent state of research: Dopsch, Goldammer and Kramml 1993, *ibid.* mining in Paracelsi time/Ludwig 1993, his Carinthian link/Neumann 1993; on Paracelsus and mining also Neumann 1995) says on the Lavant Valley, its name from washing (lavare) and the watercourses once rich in gold, that still in this time there is found "...wonderbarlich gediegen goldt rein vnd pur ohn alles feur auff hundert vnd vier vnd zwentzig schwär handtstein..." A probably slightly adulating view in line with chronicle's nature, maybe also overrating singular finds. His "handtstein" matrix-mention reminds of Sterk's 1955 results, and no indication of coarser grain native gold is extractable. Panning finds apparently just allow for sub-lupine size native gold in alluvial strata along the Kliening brook's whole course, the Wiesenau gold gravels included. The orebodies' chalcopyrite /silver-bearing tennantite (Sterk 1955, 51) contents (very rare chalcopyrite finds in Kliening's mining dumps mentioned by Riedl 1873, 12) very probably were insufficient to cause any copper-linked placer ore-gold extraction problems. Lacking transport flow for the smaller grain gold fraction's removal as well as co-recoverable ores' nature (± decomposing gold-bearing arsenopyrite/pyrite and auriferous löllingite, loose or in the matrix, had been processed by methods the Norici were familiar with before in all probability, substantial precious metals contents taken for granted) most likely allow for elimination of Kliening's locations. "Traces" of Wiesenau placer operation /mining activity are dated back to Illyrian times (Paschinger 1979 and *lit.cit.*) without any direct evidence, in line with the frequently seen derivation of mining from archaeological data on "Illyrian" /Celtic settlement in main valleys (also in the Tauern ones). Vice versa, safe existence of settlements within the upper Lavant Valley is argued by Fräss-Ehrfeld (1984, 23) in the

Kliening gold ore mining context, her statement belonging to the Noric period. There are no archaeological indications yet for Kliening deposit's Celtic time exploitation (Gleirscher 2009, 89, but there been no targeted fieldwork at all to this day too). According to Strobel (2003, 61), Kliening placers' exploitation for alluvial gold production already in classical antiquity can hardly be doubted (much the same be true of Tragin's and Lieser Valley's placers).

✘ **Tragin placer mines** /*Paternion, Drau Valley*: The ancient gold placer-mining complex over approx. 8 km length along the Weißenbach Valley, tributary to river Drau and joining near Feistritz-Paternion, is said to date back to when historical reports are lacking (Riedl 1873; alleged finds of Roman coins in the Wera Adit are mentioned by Canaval 1885/88). Contrasting to the site treated before, Tragin placer formation consists of calcified, stable gold gravels, thus (apart from old open pit mining signs near Pöllan and from Tragin up in the valley, relics of significant opencast mining there reported by Canaval 1885/88), the placer's richer strata next to valley's bottom rock all had to be recovered by underground mining. Native gold is reported to have occurred in vividly golden small platelets (verified by panning placer material rests, yielding such of up to 2 mm size, Culetto unpublished) and grains, of which the largest one recorded for the test recovery period toward the end of the 1860s (found in a bottom rock's vortex hole) weighed 2735 mg (Canaval 1885/88). Open pit mining had only made sense in the placer's end parts (of about 20 m thickness) toward the Drau Valley, but the rich(?) strata (stratum plus barren calc-cemented gravels above of more than 100 m thickness) were located nearer to the former ore structures. A site called Hammergraben (a few meters of adit still open, calcified, very narrow, low too, reminding of antiquity's haulage child labour places), in the 1860s not really passable any more to the placer's stratum of interest for probing, was very rich in gold, as legend has it.

Gold's grain size condition, the flat area demand, a breakeven transport flow etc were met locally, but decisive co-recoverable auriferous ore is almost totally lacking in the placer material (decomposed sulphides are rare finds; magnetite and ilmenite etc. usually accompanying placer gold just present in small quantities, so Canaval 1885/88; also by own fieldwork's results). Thus the deposit is to be ruled out in spite of Kahler's positive view. From the test recovery period in the late 1860s, Canaval (1885/88, information by Riedl and mining industrialist v. Gersheim) mentions finding of old artificial water courses with spots of noticeable gold enrichment in some of the reopened underground mining cavities, maybe (co)used for underground washing of the worked-through placer material. The placer mines are mentioned in a summary of the Roman age cultural situation within Carinthia in a trade/mining context by Aelschker (1885, 82, extrapolating Celtic/older gold recovery, its continuation deduced from mines' often very high/wide cavities, Riedl 1873), and in several sites two mining periods were clearly discernable (Canaval 1888, 13): i) where most erratic "mole-mining" created a real subterranean labyrinth partially for labour force and output maximization, regardless of convenience and efficiency (thus reminding Canaval of the Roman mines tenants' "economy"), and ii) more systematically done work watching economic recovery, haulage and water management. Strabo's geogr. 5, 1, 8 C 214 text (Jones 1923c) on Noreia, the place's characteristics been gold-washing and iron manufacturing sites, in Miltner's (1941, 301) opinion is met around Feistritz – Paternion and (by iron production) further up into the Drau Valley, whereas Wießner (1950, 34, 213; 1953, 268) thinks that the upper Lavant Valley would be an excellent fit. Older search for Noreia's site – in a military /metric context – is reviewed by Polaschek (1936b), Strabo's

industrial and access/distance-from-Aquileia statements on Noreia thus quite possibly going back to Polybius too. But in connection with calcified-gold-gravel mining, i.e. in an aurum fossile context, he (or Strabo) hardly had used the χρυσιοπλύσια (=gold-“washings”) term (by F.J.C.’s view of geogr. 5, 1, 8). Recent research in localization of (central Norican) Noreia puts some weight on the Ottilienkogel /Glantschach region (Strobel 2003), else concentrating on the promising Gracarca site/St.Kanzian (Gleirscher 2001; 2009), both places situated in Lower Carinthia.

✘ **“Cinderella type” placer works** (*sites with multiple primary gold deposits upriver*): After both extended Carinthian placer gold deposits’ elimination, a site which fits Strabo’s quote is looked for among the less famous locations without any extreme characteristics (Polybius for sure had told such). From an availability of coarse-grained native gold point of view, **Lieser Valley’s placers** (former local placer recovery reported by Canaval 1895 mentioning 16th century sites near Lieserhofen, cit. Scheuchenstuel 1829 and also mining archives files; Wießner 1950, 30, Schöppe 1950, Günther 2006 and Gruber 2006) fulfilled this criterion (rare findings of plated nuggets “up to half the size of little finger’s nail”, E.H. Weiss, private communication). Valley’s bottom partly is so narrow that infrastructure, i.e. federal route B99, Tauern autobahn A10 and river Lieser can hardly be accommodated. Scientific prospecting was still feasible in the late 1980s, until small hydro power plants’, canal networks’ and bank reinforcement construction (tourism projects too) made this an almost impossible task. Canaval’s prospecting results (1895, his panning probe plagued by plenty of yellow-brown greasy loam then) essentially were verified and some progress was made, like finds of coarse-grained native gold in the 300 – 900 mg range (the largest grain of 1822 mg found in a vortex hole of the bedrock) as well as of ore material (Culetto 1987, unpublished). Gold grains’ average shape is massive, ± regular and not this far off plated-ellipsoidal, sometimes over lupine size (more or less elliptic massive gold platelets of several hundred mg weight were extracted too). Panning was done using a Garrett’s® gravity trap pan in a quite lengthy procedure, caused by the limonitic or faint bluish clay material fraction, this stuff most reminding of the Strabaleben lodes’ matrix in legend. The associated heavy minerals fraction’s grain weights were of 1/4 kg scale for magnetite and 1 kg scale for dense hematite (marbled by quartz grains /veinlets), common more or less rounded garnets (mainly almandine xx) and comparatively rare rutile x fragments reached up to 2 cm, ilmenite and tourmaline grains to just 1 cm in size. The said ore, fitting the co-recoverable-ore criterion, i.a. consists of auriferous pyrite–chalcopyrite “nuggets” covered by few mms thick limonitic crusts (the biggest sulphidic nugget panned weighing 3.3 kg is sulphides – yellowy-brown quartz grains “reinforced” composite material). The occurrence of marcasite “gravels”, covered by limonitic crusts, from an ore structure’s outcrop near to the Radlbad /Lieser Valley site, is reported by Brunlechner (1893) and Friedrich (1935).

Since all of the criteria formulated can be ± fulfilled, and primary gold deposits are on hand, some of them by Salzburg Schellgaden deposit type’s continuation to Carinthia, worked by less known mines in the Pöllä /Katsch /Malta Valleys, and in the Radlgraben (Katsch and Pöllä Valleys being Lieser Valley’s uppermost sections, the others tributaries to Lieser; for mines’ history see Wießner 1950, 185-192 et lit.cit., Gruber 2006, 323-332, for metallogenesis /ore mineralogy /deposits’ details Isser 1920, Behrend 1924 and Paar 2006), some of Lieser Valley’s alluvial placers most likely fitted Polybius’ famous news. From valley’s morphological details, the target can be further restricted to locations within river’s section Lieserbrücke – Gmünd, the required soil surface to bedrock level-distance

of around 15 feet suggests final restriction to three sites: i) around Lieserbrücke, ii) near Trebesing and iii) around Gmünd, i.e. essentially to alluvial gold production sites already treated in literature. Which of these placers most likely hosted Norici (Taurisci)'s famous bonanza (if any) to be re-localized, maybe was a matter of transport flow. Placers upriver Gmünd had failed to acquire gold coming from Malta Valley, Radlgraben and the smaller tributaries, Trebesing placers had caught it – with the exception of some of the tributary flows – and the Lieserbrücke placers had caught it all (if the gold's transport rate from Lieser's upper course toward these sites was sufficiently large). There, the quite narrow valley reopens and bedrock with regrettably barren and heavy-minerals-free faint bluish clay was seen in prospecting, the local placer area obviously thoroughly worked. Finally, terrace placers also present (and mined too in the past) within Lieser Valley's section Lieserhofen – Gmünd cannot entirely be excluded as targets to Strabo's citation, but the flat-area condition most likely is not met by those locations considered. No statements backed up by prospecting results can be made on Noric bonanza's (if any) likely richness and area, the native gold contents of the clay material panned (heavy minerals fraction's and pebbles' grain ≤ 1 cm, larger grain removed) reaching up to 0.1 wt.% in maximum, but "spot" deposits' gold-clay limited to sub-m² areas at some 5 cm thickness near to the bedrock. For "re-construction" of such a rich placer deposit, 10 feet and more thick, fitting Polybius' 34,10,10–14 message, a layered or spongiform arrangement of gold migration barriers and clay layers or islands rich in gold had to be used in order to avoid incredibly rich (so most unlikely) strata nearest to the bedrock. The comparatively abundant heavy minerals fraction – its grain from silt up to gravel size "rounded" hematite and sulphide-nuggets – cemented by greasy loam indeed had met the migration barrier requirements (mainly by erosion damage reduction due to placer material's enhanced mean density), better by far than ordinary sand-gravel-loam mixture did. Aqueous solutions containing gold complexes originating from decomposing auriferous pyrite/chalcopyrite/arsenopyrite, with or without microbial support could have eventually led to (marginal) in situ - growth of local placer material's gold grains (such growth not reliably derivable from author's check of the native gold panned) or to their shape's "softening". All indications considered valley bottom's placers were able to host the reported Noric bonanza (if any to be re-localized) from a technical point of view too. Considering terrain's alteration by later placer working, archaeological traces are unlikely. Interestingly, Lieser's placers nearby Norici (Taurisci)'s tribal area came to lie *about opposite Aquileia* (in Fig.1), which exactly is Jones' (1923a) translation's text. Perhaps any "Tauern gold's" long-distance placer deposits (gold dust/platelets) in the Slovenian Drave section were worked almost simultaneously by Taurisci.

DISCUSSION AND CONCLUSIONS

The re-localization of Norici (Taurisci)'s bonanza, or alternatively, of Noric placer works/mines worth mentioning, was attempted via an axiomatic site-elimination strategy. Search criteria were derived from Strabo's Geographica 4, 6,12 passage citing the (lost) 34,10,10–14 text by Polybius whose precision is known and thus was relied on. From a scientist's point of view an element of risk remains, the (in parts technical) information been reported by a universal scholar but finally cited/extracted by a geographer. Mining historical, geographical, geological, ore mineralogical and metallogenetic literature was screened and scores were enriched/correlated with data from own prospecting activities, the details documented without reviving old prejudices. Thus, beware of supposing even

moderate chances for gold finds along the Lieser's course described, sporadic probes (of gravels from construction sites) 1990 - 2000 by the author having been almost complete failures. Other sites (e.g. Waschgang) were incorporated into Hohe Tauern national park areas. Aside geographical restrictions of the reported location's search to be considered later, there are degrees of freedom in the application /interpretation of the search criteria. These were understood and used in a more general, conventional manner, i.e. neglecting special cases conceivable. In fact, the no-mining-upon-orebody criterion accessory to the "stratiform" character and the absence of deposit's depth-continuation in (gold-bearing) ores allowed for a ± flat area "stratiform" weathering /cementation zone gold deposit upon a say limonite-siderite/magnetite orebody. The Grünleiten (iron) ore deposit /Innerkrams (limonite as irregular masses with siderite, hematite, magnetite and pyrite, this deposit likely from decomposed pyrite, Höfer 1870, 35 and Brunlechner 1884, 60f.; Kahler 1975, 124, Friedrich 1936) in the Kramsgraben (a tributary to Lieser) might fit the situation from a ferrous ore-matrix point of view, but most unlikely from morphology. Nevertheless, the Lieser Valley placers' comparatively abundant heavy minerals fraction in parts goes back to former orebodies around the Grünleitenock, at least as far as hematite (marbled by quartz veinlets and/or grains, this listed by Höfer 1870, 31, Zepharovich 1873, 147 and Brunlechner 1884, 52 for the Altenberg /Innerkrams site) and magnetite are concerned. Less known limonite/hematite deposits were mined in the neighbouring Leobengraben, a tributary to Lieser too, "Pfandl" site's quartzite dense hematite reported by Canaval (1900). There are only faint signs of a causal connection of Lieser's alluvial gold and Innerkrams iron ore deposits. Dense limonitic crusts were found on just a few gold grains (the largest weighing 192 mg), extracted by panning of material from Lieser Valley bottom's placers. Panning probes along Krams brook all failed to detect native gold (Culetto, unpublished), but their validity is quite modest due to the torrent nature of Lieser's smaller tributaries.

Site-elimination procedure's coarse-grain-gold axiom turned out to be selective, this nowhere else found fulfilled (by own panning probes) in the upper Gail Valley, Gitsch Valley, along Möll Valley, the tributaries included, and in Lavant Valley's points probed. The sites' selection/elimination procedure used revisited, geographical constraints proved helpful. But as the method was essentially restricted to Carinthian targets, scepticism is justified, especially from experts' view when maybe correlating Strabo's text to Salzburg's famous mines complexes, like the Rauris and Gastein ones. Older results from author's fieldwork seem to exclude the Rauris alpine placers (the shape-, transport flow- and flat area axioms been violated), placer rests just at Rauris' Ache's join with Salzach river near Taxenbach (grain- and flat area axioms ± fulfilled but total workable area too small; gold's fine-grains fraction found to be rather large) almost fit, but a co-recoverable ore material's occurrence is not safely settled from panning probes. Such stuff's availability and placer's extension to downriver Taxenbach were essentials. But placers (for older exploitation see Pošepný 1880, 182ff; Wolfskron 1895) along Salzach's Taxenbach – Bischofshofen river section, mainly bearing gold of platelets type (so Preuschen 1938; 1959; co-recoverable ores been *rare*, by F.J.C.'s probes) are most likely to be eliminated. Possibly, gold-shape-condition's use in the locations' axiomatic exclusion procedure was too qualifying, by its application to *native gold* grains only. Jones' (1923a) translation of Strabo's 4, 6,12 quote saying that "part of the gold is immediately pure, in sizes of a bean or a lupine, when only the eighth part is boiled away...", if the Greek text really admitted *output* geometry, would also allow for reference to gold having undergone a cementation process. Depending on annealing temperature and -duration (grain melt or growth lowered surface over volume),

refined gold grain's shape \pm gains in regularity, thus allowing for input of irregular shape grain/platelets of several hundred milligrams weight too (approx. fitting gold size axiom's lower bound). This view's impact on sites' axiomatic exclusion is that alpine, terrace and valley bottom's placers had to be reconsidered, if the grain-weight-, flat area-, sufficient transport-flow and co-recoverable-ore criteria were \pm fulfilled. So, Lieser Valley's placers probed gave an even better fit, the grain weight axiom additionally met by part of native gold's platelet fraction. Revaluation of the Wiesenau /Kliening placers did not revise their elimination made, the *grain weight* condition's lower limit unlikely surpassed by irregular shape native gold grain /sheet. And Salzburg's placer gold deposits probed revisited, the ones been axiomatically excluded remain so.

There was one more motive for restriction of mining sites' screening to Carinthia. Ancient messages had been located by referring to a place generally known. Thus, from the Polybius/Strabo passage's praecipue-in-Noricis specification – Graßl's (2000) results conclusively allowing for a target more or less in Norici's tribal area only – the gold-finds message gets indirectly linked to a mid/end - 2nd century B.C. Noric centre, be this (not yet localized central Norican) Noreia or (precursor stage, if such) Noric "mountain city" (its name not mentioned in the ancient literature sources) on/at/near Magdalensberg in Lower Carinthia. The city later became *the* Noric market place for metals (Egger 1961, Piccottini 1977), particularly for the ferrum Noricum products, but for precious metals as well. Spectacular archaeological (imperial Roman age) results in the local gold smelting and casting context are reported by Piccottini (1994; 2001), these interpreted as a direct proof of primary gold mining in Carinthia's or Salzburg's Tauern areas (also Strobel 2003, 61f). The uniqueness of Piccottini's indeed sensational archaeological finds (Caligula age moulds for casting of Noric gold, melting workshops /furnaces within a special complex of buildings interpreted as "officium" for operational /administrative imperial gold processing) combined with Salzburg/Carinthian gold-silver deposits' complexity interfere with straight attempts at interpretation of the there quoted NAA-, SEM- etc. analyses' results. Neutron activation analysis (NAA by U. Wagner, E. Guggenbichler and Ch. Flügel /TU München, acknowledged by Piccottini 2001, 56) detected gold in the furnaces' coating clay and ground plate clay specimens, and scanning electron microscopy /probe (by G. Sperl, Montanuniversität Leoben, his great results cited by Piccottini 2001, 56; G. Sperl, private communication 2008 too) of slag samples revealed irregular shape gold in quartz matrix residue, from Au:Ag ratio (usually quite variable among gold grains, Paar 2006) fitting the (primary) Tauern gold context. These exceptional results must not be diluted, but they deserve further consideration (see Gleirscher 2009, 90f. and lit. cited, i.a. noticing heat-sensitive mould material, just slight thermal alteration of furnaces' coating, slag probed maybe of docimastic origin). But there are several details obviously misunderstood and /or (mis)interpreted by Gleirscher (2009), e.g. the Noric nuggets' weight range (ib.86) and his (too qualifying, *remark by F.J.C.*) conclusion – from slag sample's gold not melted off and lead contamination been detected – that gold content's probing only was done (ib.95). Not/just partially melted grains of input mixture in slag sporadically occur in larger as well as in small scale melting (such taken to cooler surfaces e.g. by convective flow, moving vapour phase/degassing bubbles they adhere to, air stream etc.), so melting/casting and probing too remain options. Piccottini's (1994, 474f.) plausible assumption says that the gold cast into bars in Magdalensberg mountain city was a mixture of gold from several locations, the nearest ones had been Kliening/Wiesenau's sites. Kliening location veins' formation parallels Tauern gold veins' one in mineralization and age, down to fine details

(Sterk 1955, 56 and lit. cited), thus having (primary) ± “Tauern gold” off the Hohe Tauern region (fitting the gold’s grain size range detected by panning probe). From such point of view, an input mixture of native gold bearing slicks /concentrates, say from Kliening’s mines, inducing the (primary) “Tauern gold” character, and from Tragin’s placer mines (alternatively from Wiesenau deposit) – maybe even placer-concentrates themselves, gold grains frequently containing ingrown white quartz reported by Canaval (1885/88) for Tragin’s slicks – perfectly reproduced the residues: irregular grain native gold in quartz (as Sterk 1955 and observed by panning material from a Kliening’s old stamp-milling site, Culetto, unpublished), and a high iron content of platy slag (by Mössbauer spectroscopy as cited in Piccottini 2001, 56) from the slicks’ hematite and magnetite fractions. And if docimastic slag given, one just had to consider single location gold concentrate’s input. The lead contamination detected possibly is due to inputs’ minor galena contents in melting, but could come from docimastic lead use too.

Before returning to Polybius’ time, a technical remark on the Caligula age moulds already mentioned above shall be made. In imperial gold processing’s final step a quite primitive moulds’ (unique finds) usage is proven, off optimum in materials choice (Kraig site’s marble used). Expert’s statement says that gold casting using such mould, if rigidly embedded, is feasible (Ch. Grassmayr, private com. 2008, the famous Tyrolian casting specialist astonished by materials choice). F.J.C. thinks that lettering, like fine structures of its abbreviated ... ·EX·NORIC(...) derivation sequence on Piccottini’s (1994, 468) mould finds, indeed testifying Tauern gold’s and/or a peripheral alluvial gold’s admixture, hardly survived one casting run, but spare moulds’ supply been organized/neatly planned (or no special standard required). The emperor’s gold bars – where, depending on use, major alluvial gold inputs to casting should have normally rendered refining superfluous – been his property, refined gold (aurum bonum) bars played a weighty role within means of the foreign trade payment in Noric wholesale trading, as was studied by Graßl (2007, 103 and lit. cited). While evidence sensu stricto exists for the final step(s) of (imperial Roman) Noric gold processing, the proof including reliable input of (primary) “Tauern gold”, in situ - proof sensu stricto of Noric/Roman age primary gold-silver mining still is an open task in Kliening or in Carinthian/Salzburg’s Tauern. Polybius’ precise tradition had likely noted if the target to his message was off the more accessible cis-Tauern mountain crest region, specially if explanatory details had had any potential for auri sacra fames - enhancement. If the attempt at re-localization of Norici (Taurisci)’s bonanza (or just of a significant Noric mining operation) reported by Polybius 34,10,10–14 is sufficiently accurate on the whole, mine’s distance from an old hill-settlement called Teurnia – latter titled the most important prehistoric residential place of the Upper Carinthian and the Eastern Tyrolian Drau area by Heuberger (1954, 166; for archaeological data see Glaser 1992; 2002), the region’s inhabitants been Ambidravi– was 3.5–12.5 km as the crow flies: A perfect location from a logistics point of view. Norici’s authority even then indeed had included Ambidravian area (so Alföldy 1974, 35), the ancient Tragin placer mines been located in Ambidravi’s off-alpine mining region too. With Noric mountain city’s growing reputation as a commercial centre, and later on with Noricum’s annexation to the Roman Empire, mining activity in Carinthia’s ore region increased (Fräss-Ehrfeld 1984, 23). Intense woodland clearing in Gastein’s Naßfeld and Bockhart area from the 2nd century B.C. on and finally culminating around B.C. to A.D. turn (from palaeobotanic results, Kral 1993) is tentatively explained by wood demand of local gold-silver mining /smelting (Lippert 1999, 211; for Bockhart-Baukarl-Erzwies deposits see Gstrein 1993, that a former cementation zone’s enriched

ores there could have remained hidden from native Celts or Roman prospectors judged simply unthinkable by Gruber 2006, 247). Investigations on Roman age gold mining in Gastein's Radhausberg and Bockhart area (Rieser and Schrattenthaler 1999) did neither provide Roman archaeological data exceeding those reported/reviewed by Lippert (1999) in the Roman age roads context, nor mining-specific finds that could unambiguously be dated Roman age, likely due to the Radhausberg ore facies' unfortunate position, these covered by later mining periods' dumps and also rocks' debris. Functionally shape mining ironware if Noric, Roman or medieval more or less looks the same too. In-situ evidence *sensu stricto* for Roman (and pre-Roman) Noric Tauern gold mining still is missing, the dating crucial relics maybe preserved in an abandoned test pit mine sooner than in a famous location totally worked.

Concluding, Kahler's reduction of our problem from bonanza-scale to everyday mining of the Norici Taurisci shall be reconsidered. There might have been a paradigms change in Celtic precious metals prospecting after the discovery of *rich* placer strata (no matter if by natives or by Itali as Dobesch 1980, 237, and followed by the Noric gold rush as is indicated by Gleirscher 2009, 81, in chapter's title), ideally located compared to the distant alpine mining sites more or less rich in gold. Lieser Valley's numerous placers had offered both, large working area *and* quick gold output. Looking for analogues along Carinthia's larger rivers indeed could have enabled Tragin (and part of the Wiesenau) placer deposit's (re)discovery, followed by switching to larger scale operations. Growth in reserves had for sure revived Norici's gold production (reducing the Ambidrauvian alpine sites' rating until the secondary gold deposits' depletion). Noric iron versus gold mining competition's action on resource allocation had affected the precious metals' output, but statements on iron use's pre-Roman age dimension are hardly feasible (Gleirscher 2009, 101). Kahler's (1975, 120) remark – that Noricum had a war-crucial industry as a result of its steel production – in mind, and aware of Roman Empire's options among productive gold sources (like Hispanian, Gallian, Pannonian...) a scenario with almost alluvial gold production only (and minor primary gold mining in the more accessible Kliening sites, or in the distant Hohe Tauern, less been in competition with iron-ore mining) aside Norici's iron production focus is conceivable in the general perspective. Primary Tauern gold thus should possibly have proved Romans' aim only late. The factor likely most influential on continuous evolution, ensuring solid prosperity (if such terms apply to Noric/Noric-Roman slave-owning societies, no remark on slaves in mines given in Dinklage's 1976 extract from archaeological data on Carinthian Celtic and Roman age slavery) later in those days is stressed by R. Egger (Egger 1970), the past master of Carinthian archaeology: almost uninterrupted peace from Noricum's joining the Roman Empire in 15 B.C. on, lasting for over 400 years (true of the whole of Upper Carinthia with its finally maybe indeed mining crucial Hohe Tauern area). And Kahler (1975) in the Empire's Noricum-policy context says that the exchange value of four hundred years of peace, former brought by the Roman occupation, was an important one.

ACKNOWLEDGEMENTS

British gold prospector Alf Henderson's share of the work reported, by know-how transfer while the Rauris Gold Panning World Championships in 1986 is gratefully acknowledged. Special thanks are due to Prof. E.H. Weiss, Wien for crucial (unpublished) information on

results from former placer probing in the Lieser Valley, and HR G. Schön, Klagenfurt for discussions /support in mining files search. Without the mining historical work by Prof. H. Wießner and Prof. F. Gruber (his focus laid on Salzburg's precious metal mining), as well as without Prof. W.H. Paar's life's work in metallogenesis/mineralogy/characterization of the Tauern gold deposits even attempting to gain some unifying insight in the old mines' context had been a totally hopeless task. The author especially thanks Dr. J. Tomaschek, Admont Benedictine monastery's librarian, Dr. D. Neumann, Museum der Stadt Villach and Mrs. Claudia Zechner, Kärntner Landesarchiv for literature support, Prof. G. Sperl, Montanuniversität Leoben for discussion of gold extraction in ancient metallurgy, Prof. H. Graßl, Universität Salzburg for discussion of his contributions/view to/of the Strabo 4,6,12 topic, Prof. F. Gruber, Böckstein for information, partly on his results likely enhancing the probability of (Noric)Roman gold mining in the Hohe Tauern area, Monsignore H. Wurzer, Obervellach for his kind remark on old languages (medieval) practice and Dir. E. Wappis, Landesmuseum Kärnten, Mr. P. Kolle, Universitätsbibliothek Klagenfurt, Mag.^a Cosima S. Richter, Österr. Nationalbibliothek, Prof. O. Wagenbreth, emDir. IWTG/TU Bergakademie Freiberg and Bgm. R. Schratte, Marktgemeinde Hüttenberg for help in citation search. Furthermore, F.J.C thanks Prof. K. Strobel, Universität Klagenfurt for remarks on his work on Noric gold finds /Noreia's site, Prof. F. Glaser, Landesmuseum Kärnten for his special comments on archaeological facts/data concerning Teurnia and the Norici's mountain city /Magdalensberg, Mr. G. Finding, Bergbau-Museum Klagenfurt for communication of his Kliening gold finds, and KR Ch. Grassmayr, Innsbruck for his casting technology expert comment. F.J.C. also thanks Prof. Emma Dench, Harvard University as well as Dr. Chris Stanley, Natural History Museum/ London for their kind help in search of a suitable home for his data/results, unfortunately in vain. The paper also benefited from close and long-standing cooperation of KELAG – Kärntner Elektrizitäts-AG Klagenfurt and Universität Salzburg's present Department of Materials Engineering and Physics, so first-rate RD&D coordination by Dr. M. Marketz, KELAG here has to be emphasized. In the paper's old mines chart context, support by Mr. S. Culetto and Mr. W. Culetto, Private Research Associates, Obervellach, is gratefully acknowledged as is CM K. David's help, KELAG, in the mining literature context. And last but not least, the author thanks a series of landowners along river Lieser's (and also the other rivers/brooks') course for their kind permission of micro-scale prospecting activity for scientific purposes.

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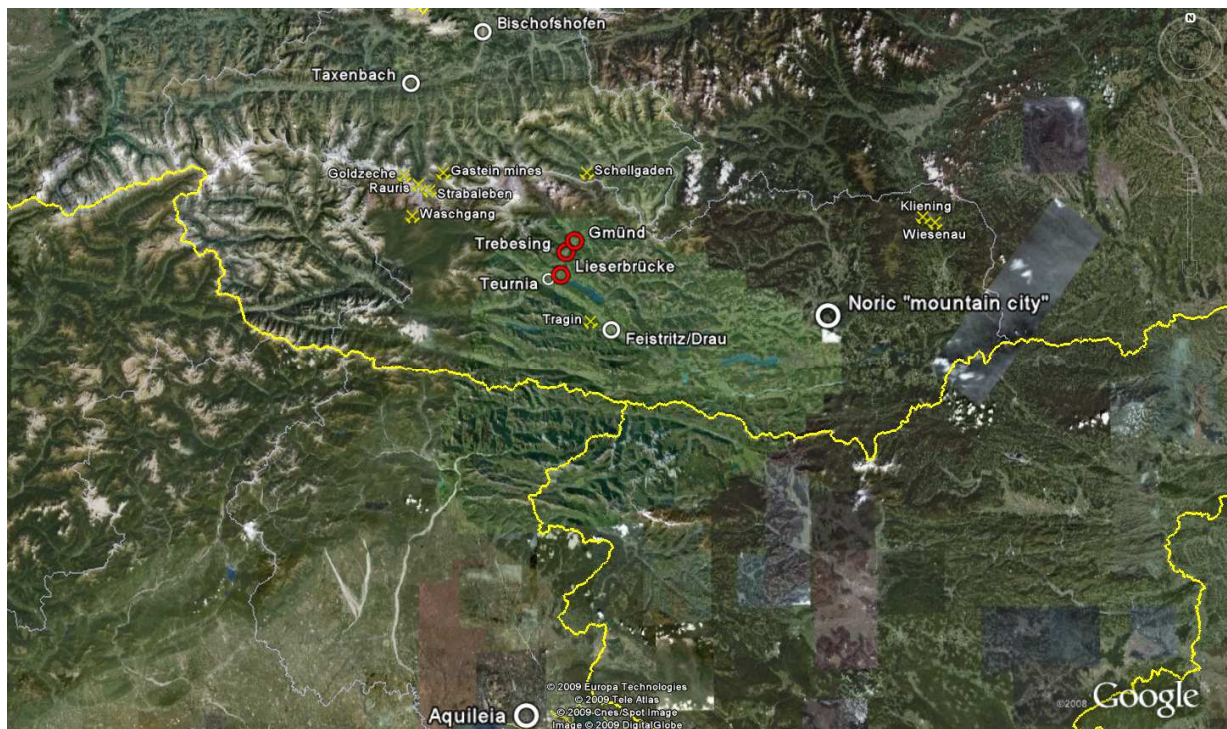


Figure 1: Historical goldmines' locations ✕ (approximate sites) and points of reference for the attempts at re-localization of a Noric bonanza reported in Polybius' Histories 34, 10, 10–14 and this quoted/recorded by Strabo, Geographica IV, 6, 12 C208. Only mines complexes in Carinthia and Southern Salzburg /Austria are shown to stress their rating compared with countless small scale placer works and mining sites also operating then. Today's state (yellow) and region (light blue) borders are drawn for orientation purposes.