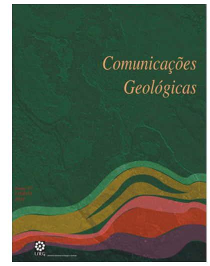
Versão online: http://www.lneg.pt/iedt/unidades/16/paginas/26/30/185
IX CNG/2º CoGePLiP, Porto 2014

Comunicações Geológicas

Comunicações Geológicas (2014) 101, Especial III, 1289-1293
ISSN: 0873-948X; **e-ISSN:** 1647-581X

The Historic Gold Mining in the High Terva River Basin (Northern Portugal)



A mineração de ouro Histórica na Bacia do Alto Terva (Norte de Portugal)

A. Lima[1*], R. M. Rodríguez[2], J. Fonte[3,4], H. Pires[4]

Artigo Curto
Short Article

Abstract: The Rio Terva drainage basin is known for many different Roman Gold Mine vestiges that can be found in the bibliography. This work is about research done in the region, principally in geochemistry anomalies and their relationship with the mining exploitations. The recent exploration campaigns in the area were able to identify in deep a gold mineralization, punctually very rich (50 g/t). There are also coarse gold as small nuggets of almost half millimetre.

All these data were integrated in a Geographic Information System (GIS) project, in order to clarify some doubts from the field work, principally in relation with the identification of real ancient gold mines instead of exploration works or another kind of structures.

Keywords: Gold Mines, Romans, Heritage, Rio Terva.

Resumo: A Bacia hidrográfica do Rio Terva é conhecida pelos vestígios de Mineração de Época Romana que se podem encontrar na bibliografia. Neste trabalho é dado especial destaque à investigação que tem sido levada a cabo nesta região, nomeadamente em termos de anomalias geoquímicas e a sua relação com as explorações mineiras. Recentemente as campanhas de prospecção na zona permitiram identificar em profundidade a mineralização em ouro, pontualmente muito rica (50 g/t). Para além disso o ouro aparece de uma forma mais grosseira, por vezes em pequenas pepitas de quase meio milímetro.

Todos os dados depois de integrados num Sistema de Informação Geográfica (SIG), permitiram a clarificação de alguns aspectos que parecem dúbios no terreno, nomeadamente as estruturas que correspondem efectivamente a antigas minas de ouro e as que correspondem a prospecção mineira ou outras actividades.

Palavras-chave: Minas de ouro, Romanos, Património, Rio Terva.

[1]Departamento de Geociências, Ambiente e Ordenamento do Território, FCUP, Rua do Campo Alegre, 687, 4169-007 Porto, Portugal.

[2]Fundación Cultura Minera, León, España.

[3]Instituto de Ciencias del Patrimonio (Incipit), Consejo Superior de Investigaciones Cientificas (CSIC), Edificio Monte da Condesa, bajo USC-Campus Sur, 15782 Santiago de Compostela, Espanha.

[4]Centro de Investigação em Ciências Geo-Espaciais (CICGE), Faculdade de Ciências, Universidade do Porto, Rua do Campo Alegre, 687, 4169-007 Porto, Portugal.

[*]Corresponding author / Autor correspondente: allima@fc.up.pt

1. Introduction

The study area was mined intensively, and for that reason it has a Mining Landscape with various examples of different kind of ancient gold mining works (both open pit and underground).

As described by many authors, most of them are from the Roman period (see references in Lima *et al*., 2011). Most of them were exploited by Romans until being economically exhausted according to those period standards (Matias, 2004). The gold exploration was based on systematic empiric criteria application, what means searching the sediments in the streams by pan. In case of positive results, the follow up would be the searching of the main deposit, primary or not (Sánchez-Palencia & Orejas, 1994 *in* Matias, 2004). If a deposit was found, both primary and secondary, shafts and/or galleries were opened to allow the reconnaissance of the mineralization and confirmation in depth, and being abandoned if there were negative results (Lemos & Morais, 2004; Matias, 2004). If the deposits were mined in open pit, either primary or even secondary, exploitation was easier, as described in Matias (2004). The ore treatment begins with the mechanic milling, followed up by hydrogravitic concentration and fusion to the gold purification.

2. Methodology

The methodology used in this research work is based on published bibliography, but principally in soil sampling and stream samples campaigns, done by different mining companies in the last century.

The stream sediments sampled by the enterprise Minas Romanas were analysed for gold and 5 more possible path elements (As, Cu, Pb, Zn and Ag). The soil geochemistry was realized by the enterprise COGEMA, in a total of 800 samples uniformly distributed in a quadrangular net of 200 m by 200 m. In this case the soil samples were analysed for Au, As and Ag.

In the office work, the geological map 6-B Chaves (1967) at the scale 1:50.000 was used, as well as the topographic maps 33 (1997) and 46 (1997) at the scale 1:25.000 and also the aerial photos from USAF 1958 flight, besides many posterior different photos from Google Earth.

3. Geological Setting

The studied area belongs to the Iberian Massif, which presents the westernmost exposures of the European Variscides and shows the most complete section from the external to the internal parts of this collisional belt. The Iberian Massif has been divided into four zones (Julivert *et al.*, 1972; Farias *et al.*, 1987), the innermost being the Central Iberian Zone (CIZ) and the Galicia-Trás-Os-Montes Zone (GTMZ), where the study area is located. The GTMZ tectonic style is dominated by the thrust regime related to nappe emplacement, two Variscan deformation stages being associated with this emplacement (D1 and D2). The tectonic evolution subsequently became a predominantly wrench regime (D3 stage) characterized by folds with subvertical axial planes and subparallel shear zones. The late Devonian-early Carboniferous compressional event described above was followed by regional extension during the later stage of the orogeny, and several E-W, NW and NE trending fault systems with an extended history of movement were developed. In the studied area, these structures are mainly represented by the Régua-Verín NE trending fault system (N20-40E). Variscan granitoids are widespread in the GTMZ and two main groups have been distinguished: synkinematic and post-kinematic. The former are S-type two mica granites (syn-D3: 315- 310 Ma) and the latter are biotite granites that were emplaced after the main phases of crustal shortening, thus being late to post-D3 (310-280 Ma) (Noronha *et al.*, 2000 and references therein). The mineralized structures are a system of quartz veins with a strike of N30-40E and subvertical dip. Most of them have a thickness of around 2 cm, although they can reach up to 20 cm. They are hosted by peraluminous muscovite-biotite granite belonging to the Chaves Granitic Complex. This is a syn-D3 granitic massif which is located in a D3-antiform core. These quartz-vein sets occur close to the Régua-Verín fault, their trend running almost parallel to that of this major fault (Cepedal *et al.*, 2013).

What is interesting is that there are much more thick barren quartz veins (can have meters of thickness) that are sterile in gold (Fig. 1).

A detailed structural analysis (COGEMA, 1990) showed that the trends of exposed mineralised veins are grouped predominantly in the NE sector and another subordinate group is in the N sector. These authors responsible for the report of GOGEMA (2009) proposed that a stress field rotation occurred during the mineralizing event, with an initially N-trending sinistral strike-slip producing one auriferous veins set, and then a rotation of the sinistral strike-slip direction to a NE-orientation producing cross-cutting veins.

The mineralogy of the ore is mainly based on arsenopyrite, sometimes occurring as idiomorphic crystals, corroded, and fractured. The pyrite is rare, and the native gold or electrum, appear generally in tiny particles with dozens of microns, in arsenopyrite and rarely in the pyrite, but mainly in the oxides resulting from these minerals (Mendonça, 2006).

4. The exploitation in the study area

The ancient works are spread across the landscape, with some examples of open pits, trenches, galleries, but also in old constructions and artefacts related with the exploitation, mainly from the Roman period. In the study area 5 main exploitation areas were identified: a) Batocas; b) Limarinho; c) Ribeira do Calvão; d) Poço das Freitas; e) Lagoa do Brejo (Figs 1 and 2).

4.1. Batocas

This region represents an extended exploitation open pit area, with a main trench surrounded by a series of parallel ones, with different depths (Lemos & Morais, 2004).

During field work for this research underground works have been detected.

4.2. Limarinho

This area presents open pits and underground works. The main trench has a strike N80ºE (Jolly & Crochon, 1989) and 50x30 m dimensions (Martins, 2005). The surrounding trenches have minor dimensions but parallel to the main one. There are occurrences of galleries, which should be for exploration due to their short development as defended by Lemos & Morais (2004). The amounts of tailings, made of fine sand to quartz boulders, surround abundantly the mined open pits.

4.3. Ribeira do Calvão

Martins (2005) identified in this area many trenches and some water deposits that were used during the exploitation works. All this area was washed and drained to the Ribeira de Calvão main stream.

4.4. Poço das Freitas

This area, as for Limarinho, presents both open pit and underground works. The main trench has a N-S orientation, with dimensions 40 m thru 50 x 30 x 15 m (Martins, 2005), and small related trenches. The galleries are also present (Harford *et al.*, 1998; Martins, 2005). They have the same interpretation as Limarinho ones, as exploration adits. The accumulation of tailings is also present in this area.

4.5. Lagoa do Brejo

Martins (2005) refers to this open pit with the following dimensions: 100 m to 120 m of diameter, and 7 m to 8 m of depth. It seems that this lagoon seems acted as the reception of washed material coming from Leiranco mountain slope. There is no evidence of underground works.

5. Discussion

The geological data shown in figure 1 demonstrate that the 5 identified areas of ancient mining are not connected with the main quartz vein, with many meters of thickness that cross the study area. Instead of that, all the 5 examples are related with centimetric veins that occur in the regional granite.

In terms of geomorphological characteristics, the mines present long and wide trenches that can be easily visible after many centuries since their opening. In common they have accumulations of tailings that surround the mining activities.

The geochemistry is especially very sensitive to identify ancient mining works. The georeferencing of all the available geochemical data for the study area is completely overlapped with the 5 main gold mining operations (Fig. 2).

The stream sediments drainage basins anomalies for gold (Fig. 2, with more than 60 ppb) are clearly related to the extensive mining operations of the central zone, that drain directly to the Terva river. In this main stream the values for gold are very high, resulting from all the ancient mining contamination.

More decisive, however, are the soil geochemistry anomalies contours, both for Au and As (Fig. 2). They clearly circumscribe the mining operations, but are missing in most of the exploration targets or other kind of activities in the study area.

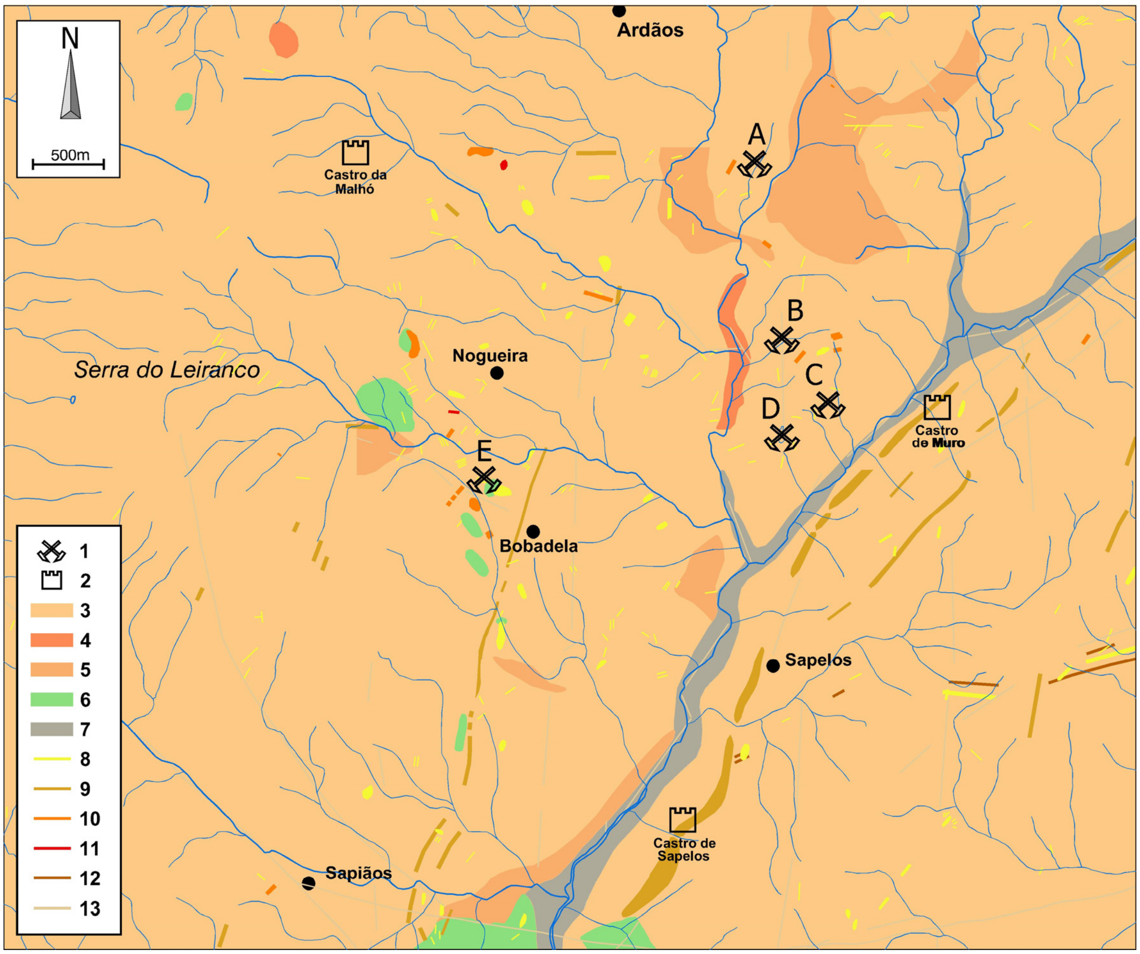


Fig. 1. Geological map of study area modified from Chaves 6-B Portuguese Geological Map 1:50.000 scale (1967): 1 – Ancient Gold Mine; 2 – Hillfort; 3 – Regional granite; 4 – Coarse granite; 5 – Fine granite; 6 – metassediments; 7 – alluvial sediments; 8 – Quartz veins; 9 – Quartz thick barren veins; 10 – Mineralized quartz veins; 11 – Pegmatite vein; 12 – Basic rock vein; 13 – Faults. A) Batocas; B) Limarinho; C) Ribeira do Calvão; D) Poço das Freitas; E) Lagoa do Brejo.

Fig. 1. Mapa Geológico da área estudada modificado a partir da Folha 6-B Chaves da Carta Geológica de Portugal à escala 1:50.000 (1967): 1 – Mina de ouro antiga; 2 – Castro; 3 – Granito Regional; 4 – Granito Grosseiro; 5 – Granito de grão fino; 6 – Metassedimentos; 7 – sedimentos de aluvião; 8 – Filões de Quartzo; 9 – Filões espessos de Quartzo estéril; 10 – Filões de quartzo mineralizados; 11 – Pegmatito; 12 – Filões de rocha básica; 13 – Falhas. Minas de ouro antigas: A) Batocas; B) Limarinho; C) Ribeira do Calvão; D) Poço das Freitas; E) Lagoa do Brejo.

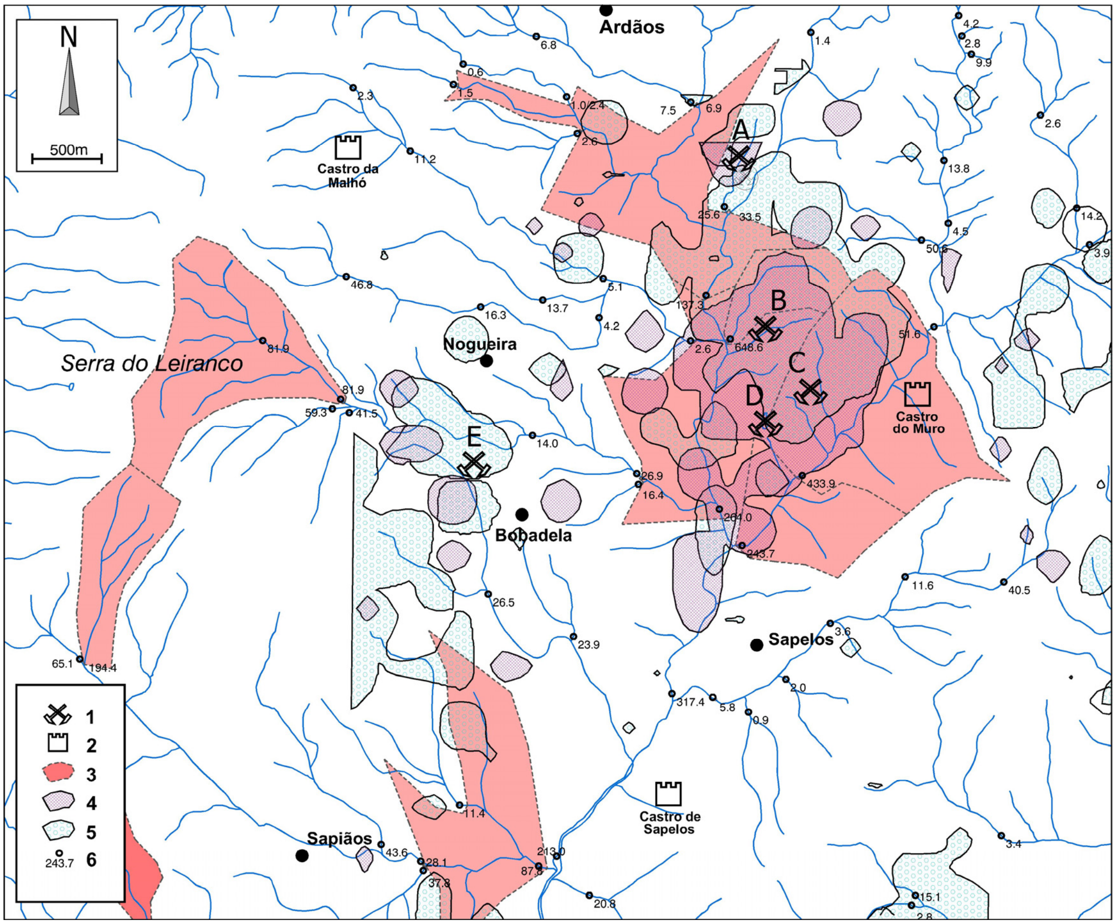


Fig. 2. Compilation of some of the geochemical data from study area (based on Cogema and Minas Romanas enterprises data). 1 – Ancient Gold Mine; 2 – Hillfort; 3 – Anomalous Au stream sediment drainage basin (more than 60 ppb). 4 – Anomalous Au soil sampling isoline (more than 50 ppb); 5 - Anomalous As soil sampling isoline (more than 77 ppm); 6 – Stream sediment sample collecting point with Au values in ppb that are considered not anomalous. A) Batocas; B) Limarinho; C) Ribeira do Calvão; D) Poço das Freitas; E) Lagoa do Brejo.

Fig. 2. Compilação de alguns dados geoquímicos da area estudada (basedos nos dados das empresas Cogema e Minas Romanas). 1 – Mina de ouro antiga; 2 – Castro; 3 – Bacia de drenagem de amostra anómala em Au (mais de 60 ppb). 4 – Isolinha de anomalia de Au em solos (mais de 50 ppb); 5 - Isolinha de anomalia de As em solos (mais de 77 ppm); 6 – locais de amostragem de sedimento de corrente com valores em Au que não são considerados.

6. Conclusions

The Rio Terva drainage basin is known by many different Roman gold mining works that can be found in the bibliography. This work proves that most of the geochemistry anomalies are related with the mining exploitations. All these data (geological, geochemical, archaeological, etc.) were integrated in a GIS project, allowing to clarify some doubts from the field work, principally the identification of real ancient gold mines, as the referred to during this work (Batocas, Limarinho, Ribeira do Calvão, Poço das Freitas and Lagoa do Brejo), instead of exploration works or another kind of structures that not mines, like the so-called Sapelos mine and Malhó mine, very close to the hillforts with the same names referred by Fontes *et al*. (2011).

Acknowledgements

We would like thanks the financial support of Projecto Estratégico - UI 0039 - 2014" with reference PEST-OE/CTE/UI0039/2014 and João Fonte acknowledges the Portuguese Science Foundation (FCT) for the SFRH/BD/65143/2009 grant.

References

Carta Militar de Portugal, 1997. *Folha 33-Serraquinhos (Montalegre), escala 1:25.000*. Instituto Geográfico do Exército.

Carta Militar de Portugal, 1997. *Folha 46-Boticas, escala 1:25.000*. Instituto Geográfico do Exército.

Carta Geológica de Portugal, 1967. *Folha 6-B – Chaves, escala 1:50.000*. Serviços Geológicos de Portugal, Lisboa.

Cepedal, A., Martínez-Abad, I., Fuertes-Fuente, M., Lima, A., 2013. The Presence of Plumboan Ingodite and a Rare Bi-Pb Tellurosulfide, $Pb_3Bi_4Te_4S_5$, in the Limarinho Gold Deposit, Northern Portugal. *The Canadian Mineralogist*, **51**, 643-651.

COGEMA, 1990. *Sector de Poço das Freitas*. Relatório de trabalhos (unpublished report), Setembro de 1990, 49 p.

Farias, P., Gallastegui, G., Fonzález Lodeiro, F., Marquínez, J., Mantín Parra, L.M., de Pablo Macía, J.G., Rodríguez Fernández, L.R., 1987. Aportaciones al conocimiento de la litoestratigrafia y estructura de Galicia Central. *Memória da Faculdade de Ciências da Universidade do Porto*, **1**, 411-431.

Fontes, L., Alves, M. Martins, C., Delfim, B., Loureiro, E., 2011. Paisagem, povoamento e mineração antigas no vale alto do rio Terva, Boticas. *In*: C.M.B. Martins, A.M.S. Bettencourt, J.I.F.P. Martins, J. Carvalho, (Coords). *Povoamento e exploração dos recursos mineiros na Europa Atlântica Ocidental*. Centro de Investigação Transdisciplinar "Cultura, Espaço e Memória"/Associação Portuguesa para o Estudo do Quaternário (CITCEM/APEQ), Braga, 203-219.

Harford, P., Plimer, I., Silva, R., Lima, A.M.C., 1998. *Minas Romanas.* Annual Report (unpublished report), 41 p.

Jolly, J., Crochon, P., 1989. *Relatório de avaliação do potencial em Ouro das estruturas de Limarinho*. (unpublished report) 30 p.

Julivert, M., Fontboté, J.M., Ribeiro, A., Nabais Conde, L.E., 1972. *Mapa Tectónico de la Península Ibérica y Baleares, E 1:1.000.000*. IGME. Memória explicativa, 1-113.

Lemos, F.S., Morais, P., 2004. *Vias augustas e mineração aurífera. Forum*, **36**, 15-56.

Lima, A., Matias, R., Mendonça, A., 2011. Contribuição para o estudo da Mineração Romana de ouro na Bacia do Rio Terva. *In*: C.M.B. Martins, A.M.S. Bettencourt, J.I.F.P. Martins, J. Carvalho, (Coords). *Povoamento e exploração dos recursos mineiros na Europa Atlântica Ocidental*. Centro de Investigação Transdisciplinar "Cultura, Espaço e Memória"/Associação Portuguesa para o Estudo do Quaternário (CITCEM/APEQ), Braga, 241-256.

Martins, C.B., 2005. *A Exploração Mineira Romana e a Metalurgia do Ouro em Portugal.* Tese de doutoramento, Universidade do Porto (não publicada), 645 p.

Matias, R., 2004. Ingenieria Minera Romana. Elementos de Ingenieria Romana. *Congresso Europeo "Las Obras Públicas Romanas"*, Tarragona, 157-189.

Mendonça, A., 2006. Geoquímica de Ouro na Região de Limarinho (Boticas - Norte de Portugal). Tese de mestrado, Faculdade de Ciências da Universidade do Porto (não publicada), 134 p.

Noronha, F., Cathelineau, M., Boiron, M.C., Banks, D., Doria, A., Ribeiro, M.A., Nogueira, P., Guedes, A., 2000. A three-fluid stage model for Au metallogenesis in granites and their metamorphic host rocks in Northern Portugal. *Journal of Geochemical Exploration*, **71**, 209-224.

Sánchez-Palencia, F.J., Orejas, A., 1994. La minería de oro del noroeste peninsular. Tecnología, organización y poblamiento. *In*: D. Vaquerizo Gil, (Coord.). *Metalurgia en la España prerromana y romana*. Diputación Provincial de Córdoba. Córdoba, 147-233.