BIBRACTE

A history of mining activity in Celtic Aeduan territory, and its environmental impact (Morvan - France)

EGS - AGU - EUG Joint Assembly, Nice, France, April 2003

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Introduction: Described by Caesar in "de Bello Gallico" in 58 BC as one of the greatest and richest oppida of Gaul, Bibracte was the most important settlement of the vast Aeduan territory.
Geomorphological anomalies, such as wide trenches and gullies, have recently been discovered on the site, and interpreted by archaeologists as being mining excavations. On this basis, they have assumed that early settlers were attracted by the abundance of mineral resources. However, this assumption is not yet an established fact, because of the lack of clear field evidence. Proof of early local mining exploitation may have been destroyed, buried or masked when the city of Bibracte was built. The present study aims therefore to document early mining and smelting activities by the means of a palaeo- environmental approach. Elemental, isotopic and pollen analyses were then performed on a peat core collected around the Bibracte oppidum (Fig 1-3).

Settings: Mount Beuvray is located in the Morvan, a Hercynian massif (900 m, a.s.l. maximum) mainly composed of granitic rocks, and volcano-sedimentary terrain with abundant polymetallic ore deposits (Fig. 3). Textual and field evidence indicates exploitation of fluorine, barite and lead from the late 18th century. The Port-des-lamberts' peat bog is almost ombrotrophic, which makes it suitable for past atmospheric input study.

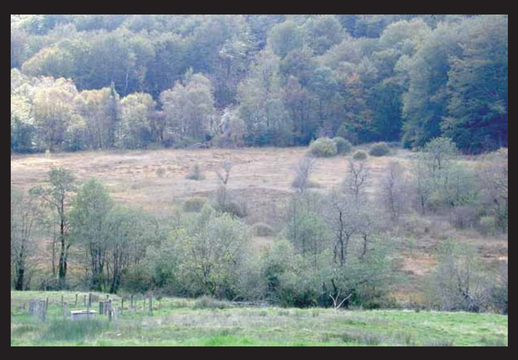

Fig. 1: The peat of Port des Lamberts

Fig. 2: Sampling with GIK-type corer

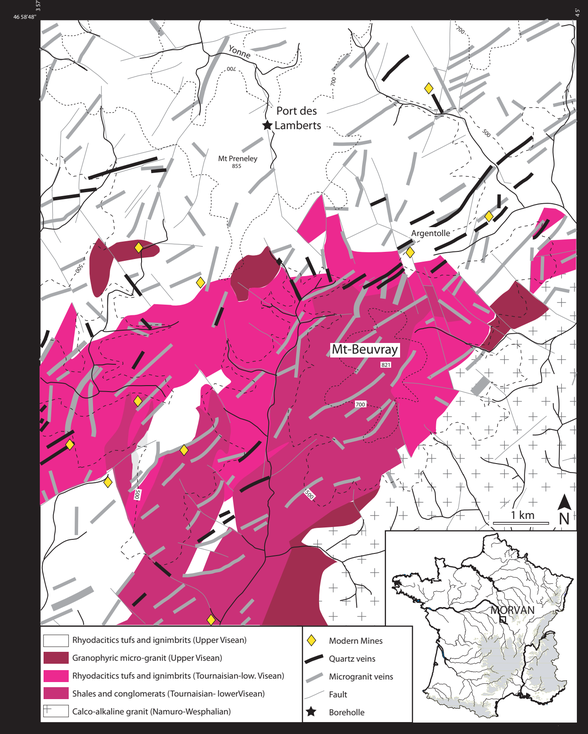

Fig. 3: Map of the area

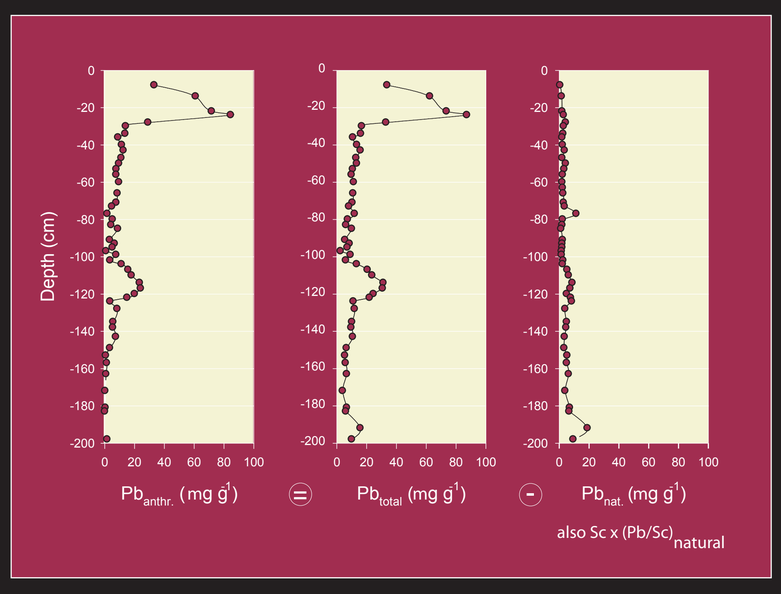

Fig. 4: Calculation of anthropogenic lead concentration ($Pb_{Anthr.}$) by subtracting natural lead ($Pb_{nat.}$ = Sc x 3.3) from total lead concentration (Pb_{Total}).

Preparation of data: Elimination of mineral matter influence is operated by subtracting from the total lead amount measured, the detrital contribution evaluated by taking as a reference a refractory lithophilic element, such as Sc. Using a (Pb/Sc) ratio of 3.3 for background allows the filtration of the minor oscillations observed in the last 40 cm of the total lead profile.

Migration or integrity: In Fig. 5, samples do not trace a line, which would have been an indicator of a unique anthropogenic source, but widen close to the Y-axis, suggesting frequent changes in exogenous lead sources. Six groups of samples can be graphically defined from the cultural periods they belong to. Their position is incompatible with any post-depositional migration within the peat column.

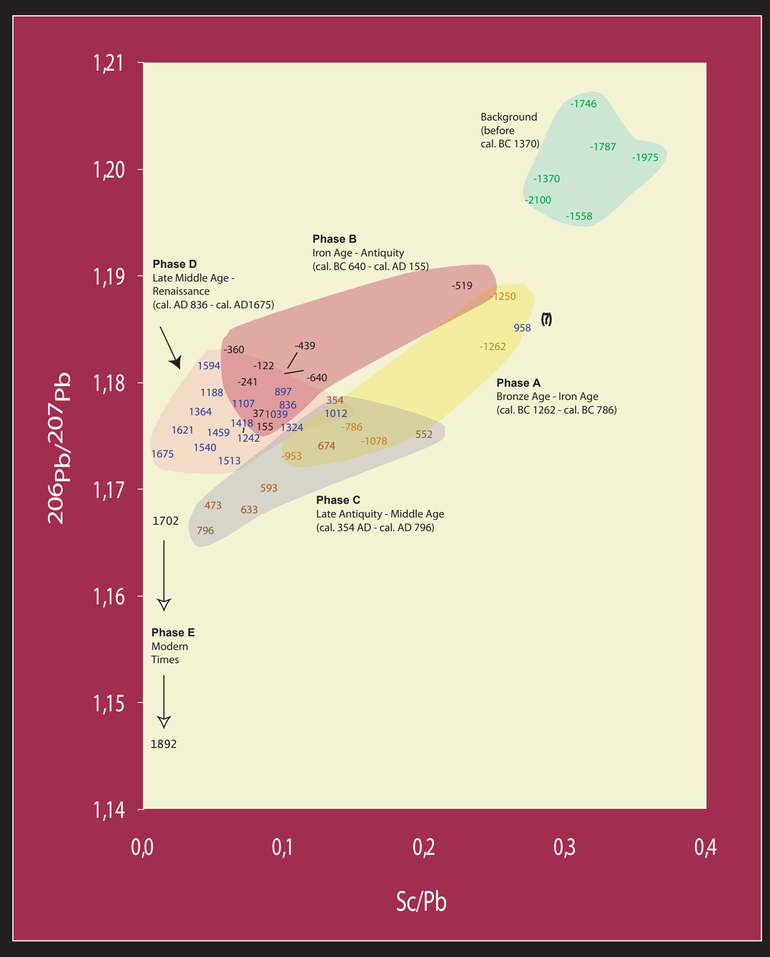

Fig. 5: $^{206}Pb/^{207}Pb$ versus Sc/Pb

Historical interpretation: The Late Bronze Age (beginning of PAZ 2a) records an important fall in *fagus* (beech) percentage, while the low percentage of anthropogenic pollen indicators does not indicate any agro-pastoral extension (Fig. 6). At that time, the earliest substantial human-derived inputs are indicated by a sizeable increase in anthropogenic lead fluxes, while $^{206}Pb/^{207}Pb$ ratios move down towards anthropogenic signatures. Vegetation cover was probably affected by selective deforestation performed to face up to increasing energy demands for mining and smelting [1-2].

At the apogee of the Aeduan civilization (first third of PAZ 3a), *fagus* taxa collapse again, whereas anthropogenic lead fluxes peak. Such a lead peak has been often documented from continental Europe [i.e. 3] to Greenland [4] and attributed to Rio Tinto emissions. However, local sources may have acted as point-sources completely obliterating any other remote signals [2,5]. Moreover, the Rio Tinto isotopic signature (1.163) [6] is incompatible with those measured in the core (cf Fig. 5).
The Aeduans were fine metalworkers. In addition to numerous bronze workshops installed at Bibracte, our results suggest the presence of extensive mining activity which could explain, at least in part, their wealth.

Fig. 6: Lithology and pollen diagram organized in pollen assemblage zones (PAZ). $^{206}Pb/^{207}Pb$ ratios and anthropogenic lead fluxes are also represented on a chronological scale.

After the Gallic War (end of PAZ 3a), the complete social reorganisation set up by the Roman administration probably led to a reduction in local mining operations. Later, the entire population of Bibracte was transferred to found Augustodunum, 25 km away and local exploitation collapsed.

Phases are also recognised from the 11th century to Modern Times. They are mostly linked to modifications in plant cover.

Conclusion: The entire set of new geochemical and pollen data is in good agreement with the sparce archaeological and historical knowledge available. The use of isotopic geochemistry combined with Sc correction enables a controlled calculation of anthropogenic versus natural materials to be computed. Our results also tend to confirm that the Mount Beuvray area was an early mining centre.

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