

An aerial photograph of a wide, muddy river. On the left bank, there is a small settlement with several small, simple houses with blue and green roofs. The surrounding area is a mix of green trees and brown, sandy soil. The text is overlaid on the image.

APPLICATION OF Pb ISOTOPES IN GOLD TRACEABILITY

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The Brazilian Federal Police's **Clean Gold Programme** seeks, in different ways, to contribute to the effective fight against illicit activities in the gold production chain in Brazil and Latin America.

Different criteria have been employed for the confirmation or denial of alleged and verified provenances.



Concerted solutions among Latin American countries regarding the traceability of gold exploited on the continent would have direct impacts on global geopolitics.

Host countries of mining companies operating in the region and importing countries can contribute with proposals to address the lack of control in the gold production chain.





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Challenging the traceability of natural gold by combining geochemical methods: French Guiana example

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Technical Note | [Full Access](#)

Distinguishing Between Legally and Illegally Produced Gold in South Africa[†]

Richard J. Roberts Ph.D. ✉, Roger D. Dixon M.Sc., Roland K. W. Merkle Ph.D.

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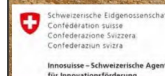
Main scientific reference surveys



Analytical Tools to Constrain the Origin of Gold from Conflict-affected and High-Risk Areas

Scoping Study Based on the DR Congo

Characterization of gold ores - the basis of gold traceability



Barbara Beck, University of Lausanne

Stefan Ansermet, Geological Museum Lausanne

Jonathan Jodry, Metalor Technologies SA, Marin-Neuchâtel

Massimo Chiaradia, University of Geneva

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Technical-scientific parameters applicable in the Clean Gold Programme for traceability and definition of gold provenance:

Geology of mined deposits

Morphologies

Mineralogy

Chemical composition

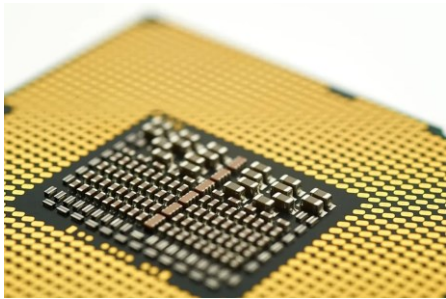
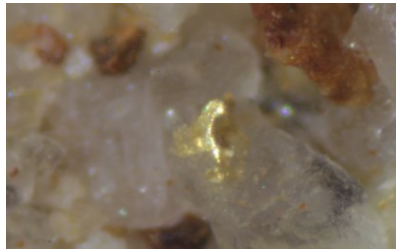
Isotopic composition

Artificial markers



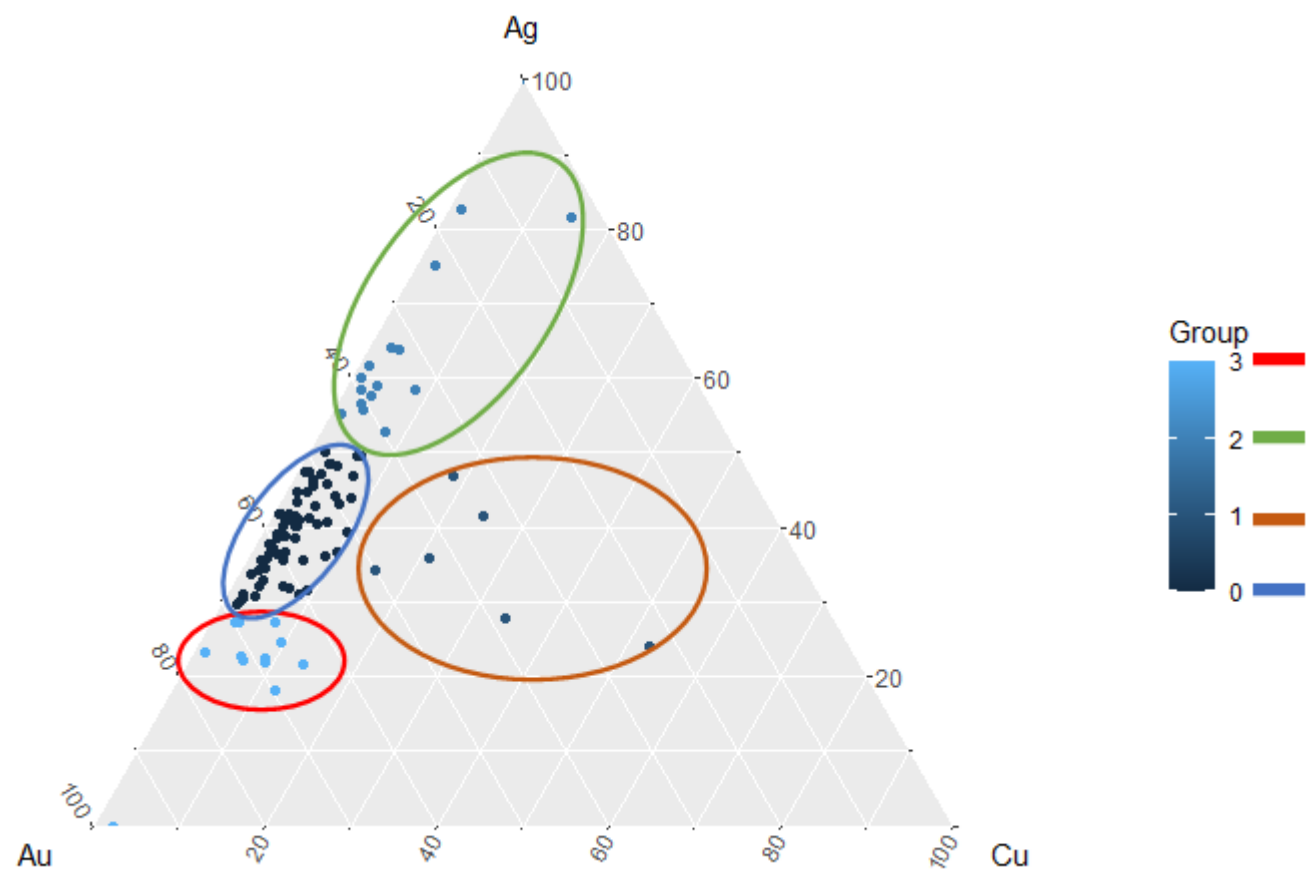
The question being in studies at the Federal Police of Brazil, University of São Paulo and the University of Brasilia is whether, throughout the production chain, this isotopic signal, a signature inappropriately called the "DNA of gold", can serve as conclusive proof of its provenance.

Several other research and regulatory institutions participate in the efforts of the Clean Gold Programme



Two analytical steps have been used for the most immediate answers required by the criminal prosecutors:

- Portable x-ray fluorescence (elemental geochemistry) equipment allows definitions on population groupings, as well as distinction between stages of refining of the seized gold.
- Laser ablation associated with an inductively coupled plasma mass spectrometer (LA-ICP-MS) for analysis of Pb isotope ratios.



Purification of gold from its ore decreases the concentration of trace elements found in the alloy metal, but is not able to alter the isotopic ratios, allowing the conservation of isotopic signatures related to the primary source of the metal.

The identification of these isotopic ratios in the metal, together with compositional geochemical analyses, make up the most secure tool for gold provenance determination.

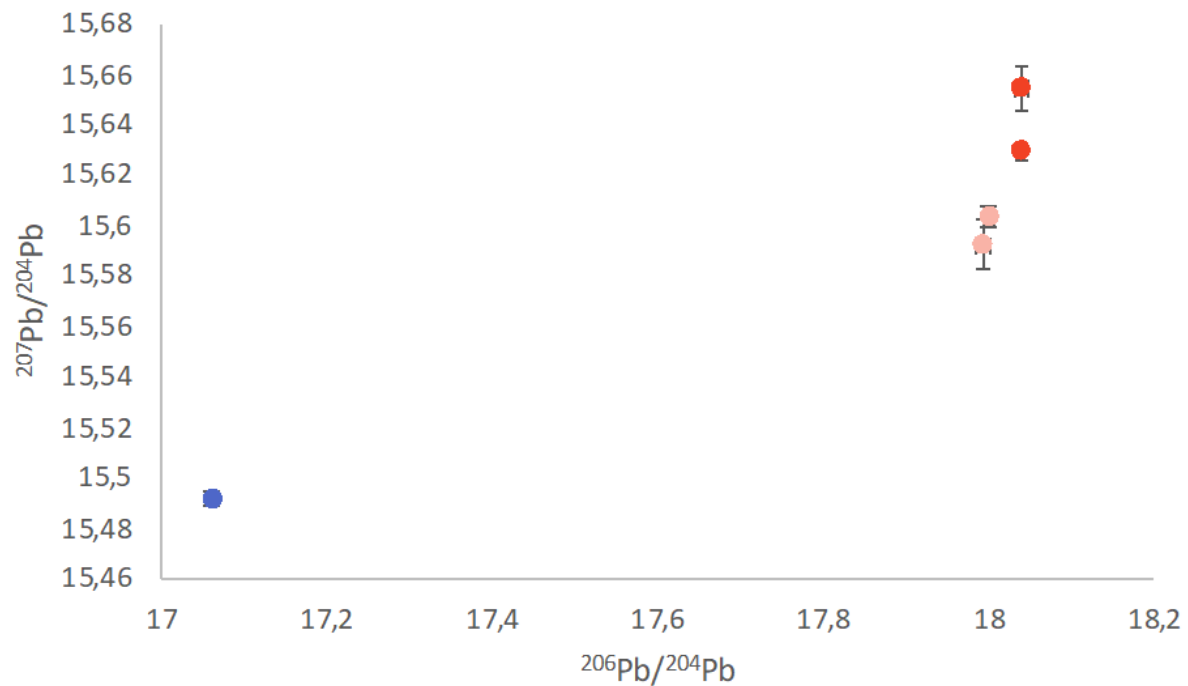
All gold found in nature contains impurities. The Pb often present in natural alloyed metal is usually in the form of four isotopes:



The relationships between these four isotopes allow the geochronology of the metal and the correlations with its natural deposits

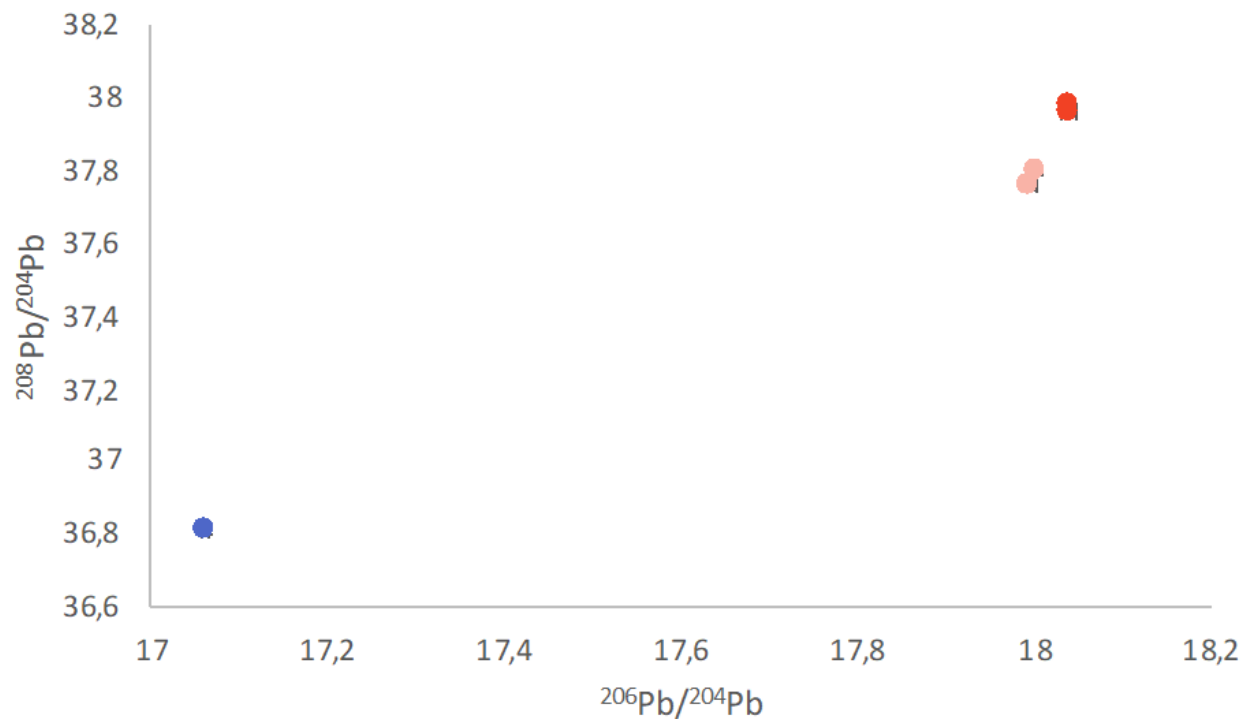
Preliminary results

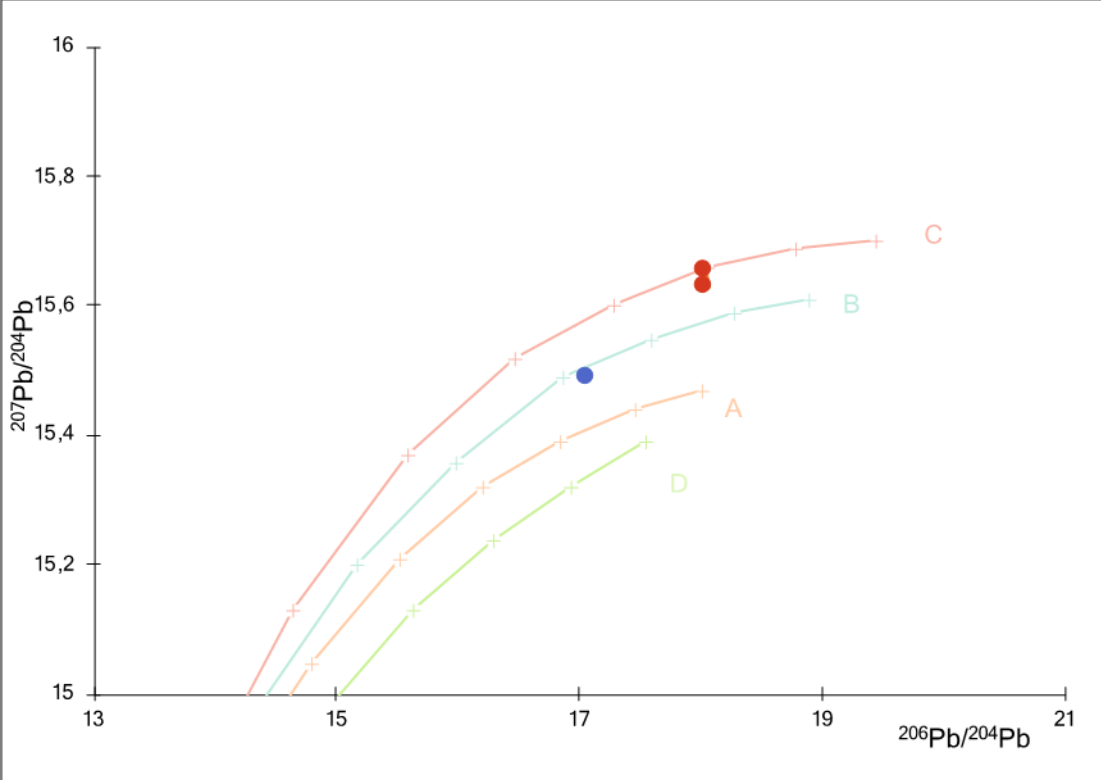
Isotope ratio analyses have proved effective in a case where there is the possibility of comparing samples collected from questioned materials, at early stages of processing, with those obtained *in situ*.



These two graphs indicate that the samples from two questioned gold bars lots are the same as each other and very different from the sample from another lot.

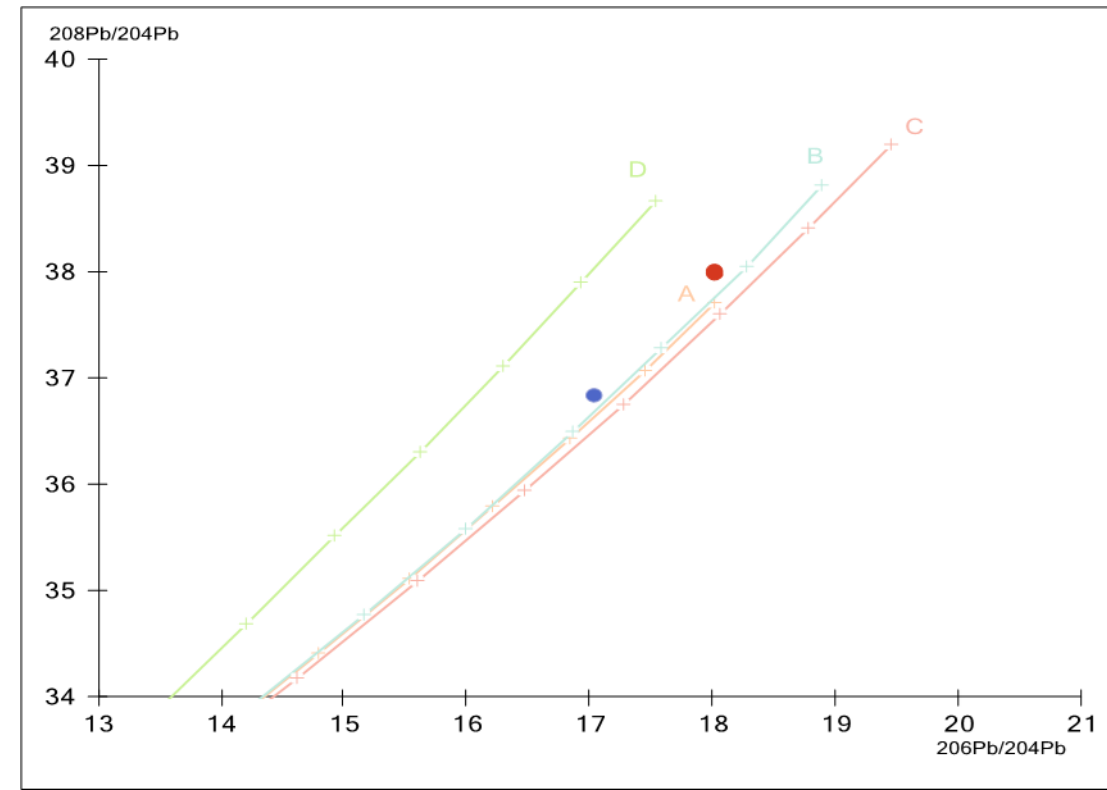
This is indicative of the use of different gold ores in their manufacture, or by mixing in different proportions gold from different places, or by gold coming from different places.





In these Plumbotectonics charts (Zartman & Doe, 1981), which associate the isotopic signature of the ore with the geological environment, we can also observe that there are differences between the two lots (same symbology used in the first charts).

Apparently, the Pb found in one of the lots is younger (in geological history), with age close to 0.8 billion years, while the other seems to be older, with age around 1.2 billion years. This is not a precise dating method, but it does evidence that the lots have significant isotopic difference and have gold associated Pb coming from different locations.



Progressively, data banks of Pb isotopic ratios from different Brazilian deposits have been organized for comparison with data banks obtained from pieces with suspect origin.

Today, the Brazilian Federal Police has around 600 samples in the preliminary composition of its National Auriferous Profiles Bank (BANPA).

Thank you for your attention.

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