Petrophysical laboratory measurements of two ore formations in Southern Finland

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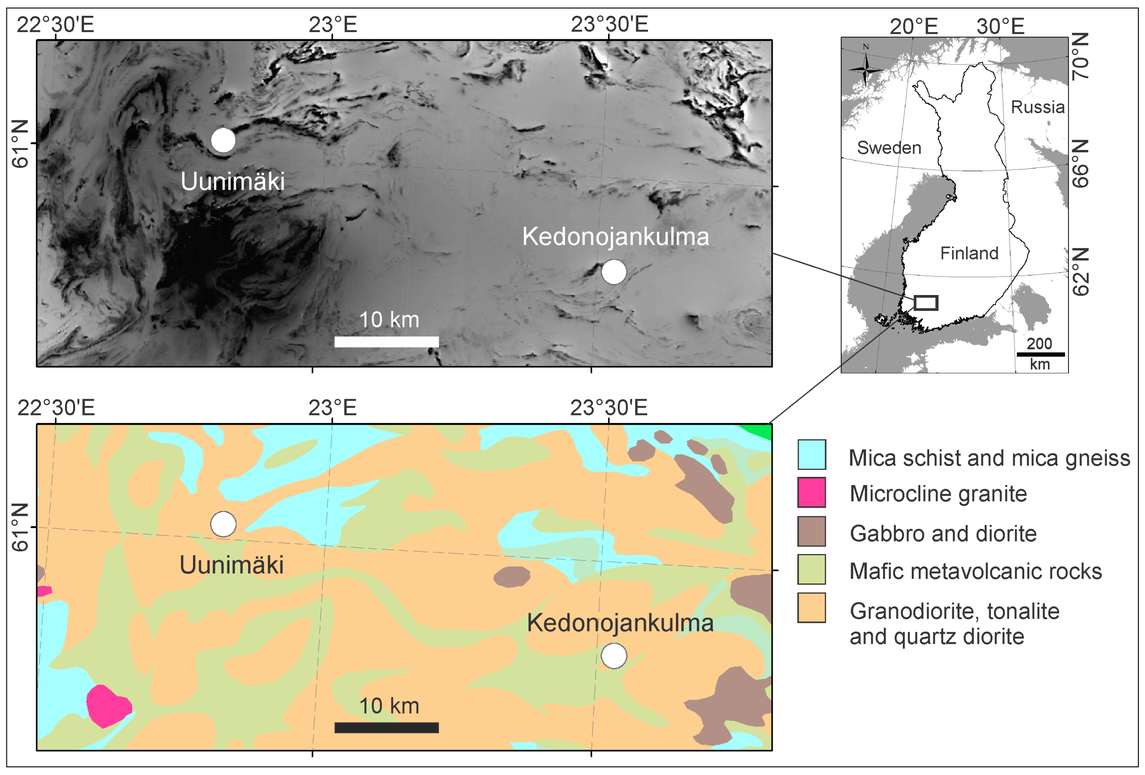
Petrophysical laboratory measurements of mineralized samples and ores have been carried out on an orogenic gold deposit in Uunimäki and a porphyry type Cu-Au deposit in Kedonojankulma in the Paleoproterozoic Häme belt of Southern Finland. The study areas were selected utilizing airborne geophysical data. The main aim of the study was to identify and characterize the alteration processes that are reflected in the physical properties of the rocks. As the known ore bodies are related to alteration zones and because detailed petrophysical investigations at outcrop scale can delineate differences between ore and host rocks, the applied methods have relevance to exploration.

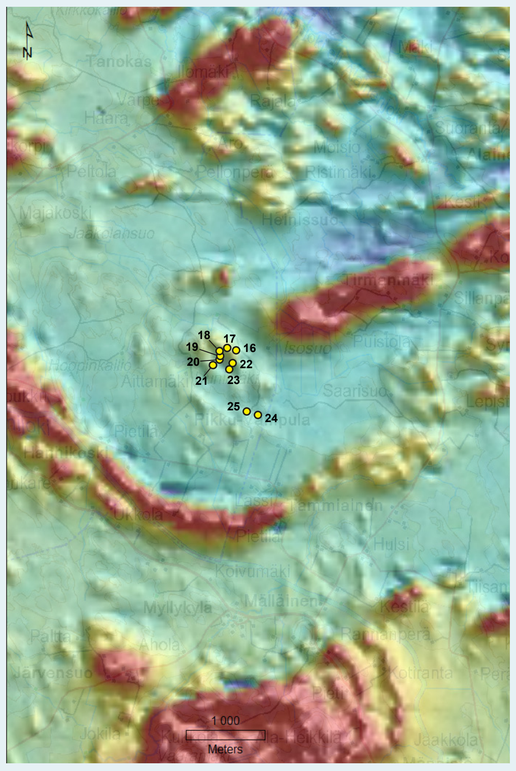
The main measured petrophysical quantities are magnetic susceptibility, remanent magnetization (NRM), density and electrical conductivity. In addition, measurements on anisotropy of magnetic susceptibility (AMS) and magnetic mineralogy by rock magnetic tests form an essential part of the investigations. Additionally, in Uunimäki the petrophysical properties were correlated with geochemical data from three drill cores.



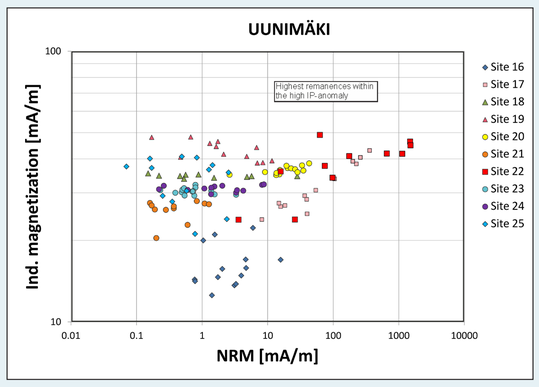
Aeromagnetic and bedrock maps of the Häme belt showing the study areas of Uunimäki and Kedonojankulma.
Aeromagnetic map of Finland – Digital map database [Electronic resource]. Espoo: Geological Survey of Finland [referred 29.07.2013].
Bedrock of Finland - DigiKP. Digital map database [Electronic resource]. Espoo: Geological Survey of Finland [referred 29.07.2013]. Version 1.0.
Available at: *http://www.geo.fi/en/bedrock.html*

Uunimäki

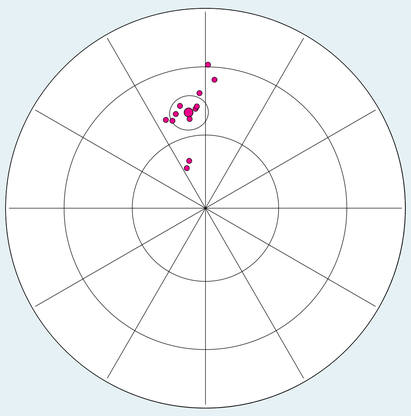
In the Uunimäki gabbroic occurrence (orogenic gold deposit) the highest magnetization values and electrical conductivities correlate with strong IP anomalies. Rock magnetic analyses show that in the samples of highest magnetization, which are believed to represent the most altered part of the deposit, the only magnetic mineral is monoclinic pyrrhotite with exceptionally high Curie temperature of 350-370°C. The less altered areas show dominance of magnetite. AMS directions are characterized by NW-SE striking, approximately vertically dipping magnetic foliations and vertically plunging magnetic lineations. Geochemical correlations of the three borehole cores show that the occurrence of gold is only weakly correlated with other heavy metals. From petrophysical parameters, gold is best correlated with inductive conductivity, consistent with the occurrence of pyrrhotite.



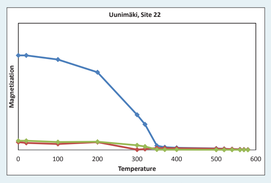
Aeromagnetic map (regional airborne geophysical surveys by GTK). Magnetic anomalies at Uunimäki coincide with electrical conductivity anomaly measured by IP method (GTK ground geophysics).



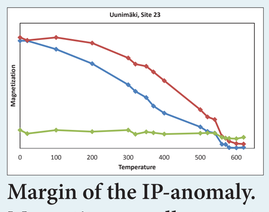
Typically weakly magnetized. The lowest magnetizations at the margins or outside the IP anomaly.



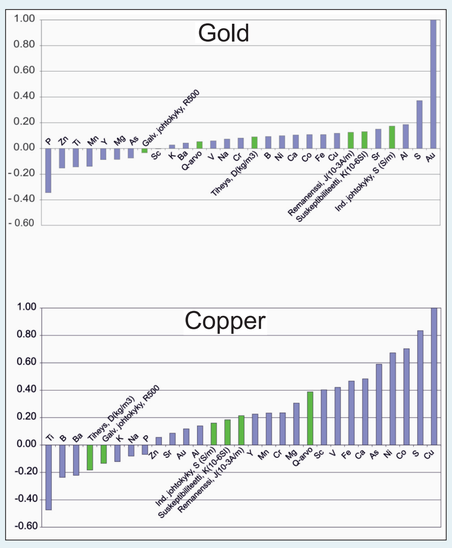
Only site 22 with the highest NRM and IP-anomaly values shows the Svecofennian remanence direction. The youngest magma pulse?



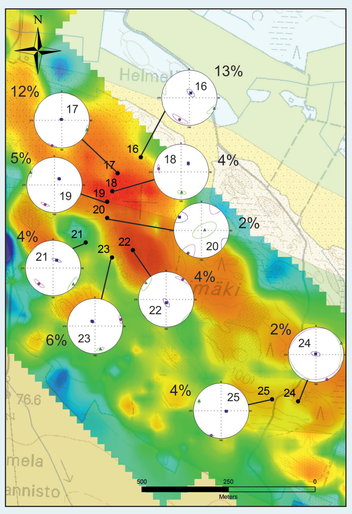
Highest IP anomaly. Only pyrrhotite with exceptionally high Curie temperature (370°).



Margin of the IP-anomaly. Magnetite + small amounts of pure pyrrhotite.



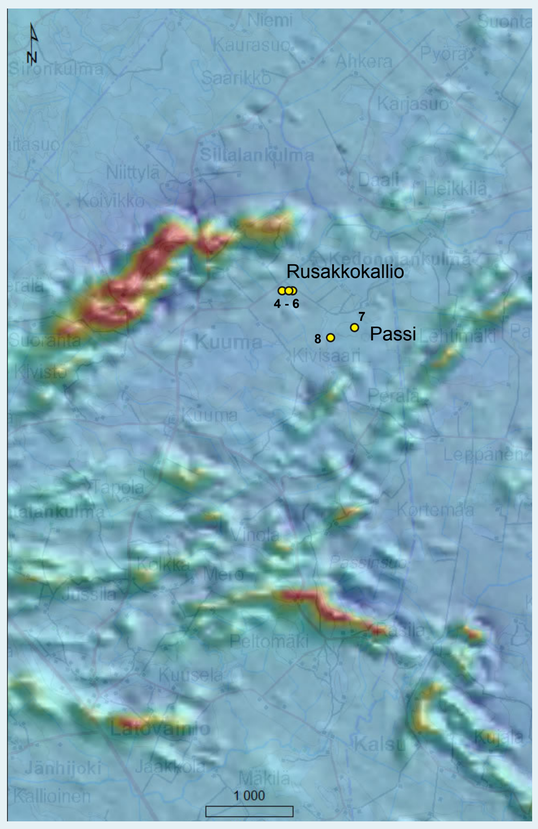
Correlation of gold and copper with petrophysical properties and other elements.



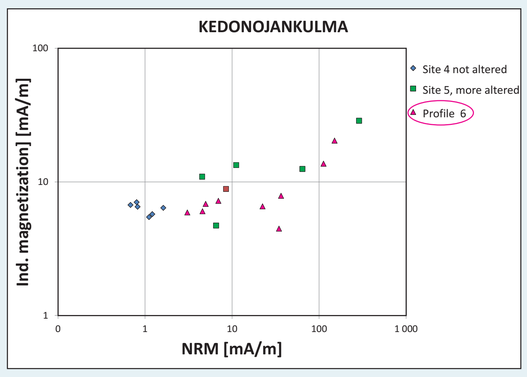
AMS directions and degree of anisotropy (%). Background map electrical conductivity by IP method.

Kedonojankulma

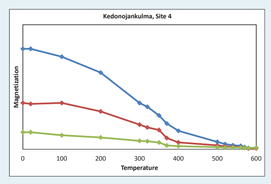
In the Kedonojankulma quartz-plagioclase porphyrite occurrence (porphyry type Cu-Au deposit), the induced and remanent magnetizations are slightly higher in the altered auriferous shear zone than in the less altered host rock. According to rock magnetic tests, in the altered zone the only magnetic mineral is monoclinic pyrrhotite with high Curie temperature of ca. 370°C, while in the host rock the main magnetic mineral is titanomagnetite. Based on AMS data the most altered quartz-plagioclase porphyrite in Rusakkokallio also has the highest degree of anisotropy.



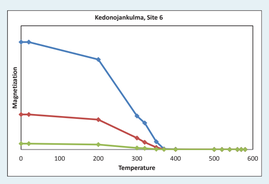
Aeromagnetic map (regional airborne geophysical surveys by GTK).



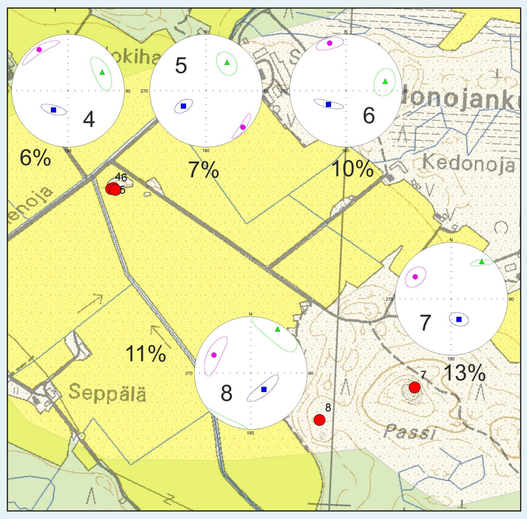
Rusakkokallio. Typically weakly magnetized. The lowest magnetizations are found outside the shear zone proper.



Magnetite + pyrrhotite in the unsheared Q-plg-porphyrite.



Pyrrhotite with unexceptionally high Curie temperature (370°C) in the sheared Q-plg-porphyrite.



AMS data showing higher anisotropy (%) in the Passi tonalite than in the Rusakkokallio Q-plg-porphyrite.

Profile 6 across the shear zone.

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