EGU22-11734, updated on 19 Aug 2022
https://doi.org/10.5194/egusphere-egu22-11734
EGU General Assembly 2022

Application of (U+Th)/^{4}He hematite geochronology to the Caldag lateritic Ni-Co deposit, Western Turkey: implications for multi-stage weathering events during interglacial periods

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Lateritic Ni-Co deposits are supergene deposits that develop due to intense weathering of the underlying ultramafic parent rocks and/or their serpentinized equivalents under tropical to sub-tropical climatic conditions. These deposits are important sources of valuable products such as iron, aluminium, nickel and cobalt. On the other hand, they directly point out typical climatic conditions. In this regard, geochronological studies on these deposits are very valuable to determine the timing of these paleo-climatic conditions that is not only important for better understanding of the paleoclimate of a region but also implying the favourable weathering period that can be targeted in exploration of undiscovered lateritic deposits in a region. Although there are limited studies about absolute dating of lateritic Ni-Co deposits by Ar/Ar dating of Mn oxides, there is no study on application of (U+Th)/^{4}He hematite geochronology to these deposits.

The main aim of this study is to apply hematite (U+Th)/^{4}He dating to the well-preserved Çaldağ lateritic Ni-Co deposit in Western Turkey. In this regard, we sampled the different parts of the lateritic profile from the different laterite zones at the Çaldağ deposit. In addition, we determined the different phases of iron oxides in order to identify the primary hematite, formed during primary lateritization with the help of polished thin section analyses. Then, we applied Scanning Electron Microscopy (SEM) analysis and TESCAN Integrated Mineral Analyser (TIMA) mineral mapping to identify the suitable areas on primary hematites for (U+Th)/^{4}He dating. Finally, we obtained credible (U+Th)/^{4}He ages from the four selected hematites.

We detected primary hematites at the base of the lateritic profiles (transition between the limonite zone and altered serpentinite) that are only in-situ parts of the laterites exposed in two different pits in the deposit. The ages we obtained from the hematites indicate 501.5 ky, 205.8 ky, 175.4 ky and 63.4 ky that are getting younger at the direction of weathering and corresponding to the interglacial periods recorded for the surrounded region. The ages propose that although the main intensive lateralization period is suggested as Middle Eocene or Miocene, the weathering processes should have lasted until Quaternary by some interruptions (?) during interglacial

periods. Permeability of the overlying limestone should have been enhanced by the active tectonics of the region that in turn caused progressive deeper weathering during humid (and warm?) climates at interglacial periods. Briefly, our results suggest that in contrast to the short-living lateritization model for lateritic Ni-Co deposits, they may have multi-stage weathering history throughout their long-lasting development.

This study presents the first hematite (U+Th)/^{4}He dating of lateritic Ni-Co deposits and demonstrates the reliable use of this method on these deposits after a careful selection of hematite samples. In addition, the study has implications on potential contribution of dating lateritic weathering on understanding the paleoclimate of a region. Finally, knowledge of the favourable paleoclimatic periods of weathering of a region may help in determining the potential areas on ultramafic exposures for discovering new lateritic deposits.

This study was supported by the Scientific and Technological Research Council of Turkey (Grant No: 120Y275)