

Dating to provenance: ESR signals in quartz

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Electron spin resonance (ESR) detects unpaired electrons in materials. As natural radiation creates unpaired electrons in minerals, the ages can be estimated by ESR measurements when natural radiation dose rate is estimated. Natural minerals such as calcite, aragonite, hydroxyapatite, and quartz were found to be subject of dating.

As quartz is one of the minerals most abundant on the surface of the earth, there are many applications using quartz ESR signals. Dating of fault movements was first category of events proposed for dating using ESR signals in quartz. Tephra is the second, then sediments, and flints were found to be the subjects of ESR dating of quartz.

The E_1' center is a lattice defect in quartz with an unpaired electron at an oxygen vacancy. Although this signal cannot be used for dating of Quaternary era, the number of oxygen vacancies in quartz was found to have correlation with age up to 1 Ga. It is possible to fingerprint quartz with the number of oxygen vacancies, hence, with the age of crystallization, as the value is not affected by the environment for the time period of Quaternary. Finger printing of dust sources was successful for loess in Japan. Together with impurity centers (Al, Ti-Li, and Ti-H centers), provenance studies on river sediments are now in progress.

Keywords: ESR, dating, quartz, provenance