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Luminescence and ESR for dating and earth/planetary science

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Electron spin resonance (ESR), thermoluminescence (TL), optically stimulated luminescence (OSL), and cathodoluminescence (CL) are methods based on solid state physics. They have quite long been used to study minerals, but not used to detect environmental change or large events quantitatively. ESR detects and quantify unpaired electrons, which are formed by radiation associated with lattice defects and with impurities. TL and OSL, based on the same principle, detects electrons formed by radiation and trapped at lattice defects and impurities, by observing the light which is emitted at the time of recombination. The major applications of these three methods have been dating. In particular, OSL dating method has become one of the most popular techniques in dating Quaternary sediments, like carbon-14 method. ESR dating method has succeeded in dating calcite, aragonite, and hydroxyapatite, however, still has many problems in dating quartz, which is one of the most popular minerals on the surface of the earth. CL is luminescence emitted when the mineral is irradiated by electrons, which is associated with lattice defects and impurities. CL has been used to check zoning which cannot be detected by SEM or by major element analysis when zircon is used for dating.

All these four methods detect small features in crystal such as lattice defects or impurities. New applications with these methods are now emerging such as identification of the source materials and detection and quantitative determination of shock events, in addition to conventional dating. In the presentation, the principle of the technique and the dating application, their current status, and these new application will be summarized.

Keywords: ESR, OSL, TL, CL, dating, luminescence