ment techniques, the thermoluminescence response of these minerals can be employed to investigate a number of geological problems.

The phenomenon can be broadly subdivided into (1) radiation-induced thermoluminescence and (2) non-radiation induced thermoluminescence. With varying degrees of success, the first type of thermoluminescence has been utilized in the investigation of radiation-damage and radiation-dosimetry problems. Among the areas investigated have been:

(*a*) Geochronology of carbonates, fluorite, quartz, and feldspars in deformed and undeformed sedimentary rocks, meteorites, fluorite deposits, Recent lava flows, and ancient pottery.
(*b*) Stratigraphic correlation of carbonate rocks.
(*c*) Paleoclimates and deglaciation of carbonate rock areas.
(*d*) Geothermometry of dykes, carbonate minerals and meteorites.
(*e*) Studies of the radiation environment of meteorites and Recent shells.

The second type of thermoluminescence may be related to a number of possible causes including stress, trace elements, mineralogy, phase transformation, and adsorbed gases. In this area, investigations have included:

(*f*) Variation in remnant stress conditions in the vicinity of meteorite craters (carbonate rocks), nuclear explosions (halite), faults and deformed sedimentary rocks, and artificially deformed ice, carbonates, and feldspars.
(*g*) The distribution of (mainly) non-radiation induced thermoluminescence around certain hydrothermal and metasomatic ore deposits in both carbonate and feldsspathic rocks.

In addition, the phenomenon lends itself to a number of laboratory techniques including the evaluation of the radio-active content of weakly radioactive materials, gas adsorption phenomena and the distribution of calcite and dolomite in carbonate rocks.

Tracing of the movement of sediments in streams by making use of the strong thermoluminescent response of artificially irradiated quartz grains has been proposed.

THE ROLE OF EXCITED ELECTRONS IN "GROUND PREPARATION" FOR REPLACEMENT ORE DEPOSITS

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The localization of replacement ore mineralization can sometimes be ascribed to fold or fracture structures or pre-ore alteration, but in other cases the reasons for the emplacement of an orebody are more obscure. A possible basic cause for pre-ore alteration or ore-bearing solutions having reacted more readily with one portion of an apparently homogeneous rock unit may have been the presence of large numbers of lattice defects and excited state electrons in minerals of the country rock.

Lattice defects which are not directly due to initial crystallization may be caused by either ionizing radiation from radioactive materials, *or* unrelieved stress, *or* the introduction of trace elements into the lattice by metasomatic processes, *or* recrystallization due to heating by igneous intrusions. Both lattice defects and excited electrons may be generated by ionizing radiations, while other defect-forming mechanisms cause electrons to be raised from the ground state to an excited state in order to maintain electroneutrality in the crystal. Many such defects are metastable and tend to be destroyed (with a return of the electrons to the ground state) by either thermal annealing or chemical processes such as weathering or hydrothermal replacement.

Thermoluminescence studies in the vicinity of a number of replacement ore deposits suggest pre-ore "ground preparation" by unrelieved tectonic stresses or recrystallization. In theory, concentrations of low level radioactivity or "activating" trace elements should have the same effect. Identifiable thermal annealing effects are rare and most decreases in lattice defects and excited electrons appear to be due to chemical processes.