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Thesis abstract

Thesis title: Studies of quartz luminescence sensitivity relevant to dating and dosimetry
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Quartz luminescence sensitivities, both OSL and 110°C TL, to irradiation dose were studied. The sensitivity is expressed as the ratio of luminescence centres (L) to non luminescence centres (R), and is explained using a model in respect of its changes with dose, heating and UV exposure. A modified model is introduced involving multiple R hole centres. It is found that only one type of R centre is involved in the OSL sensitivity change, and it is shared with the 110°C TL. However, more hole centres are involved in production of the 110°C TL.

Experiments involving annealing at various temperatures indicate that sensitivity changes of both OSL and 110°C TL signals are temperature dependent. At temperatures below 500°C, different filling and emptying of R and L centres is the dominant process and governs the sensitivity changes. There is a linear relationship between the OSL sensitivity and 110°C TL sensitivity with regeneration dose. Most holes can be transferred from R centres to L centres by annealing at 500°C for 10 minutes. Above 500°C, the sensitivity change results mainly from the destruction of R centres. The initial destruction of R centres happens at the first phase change of quartz at 573°C. At the second phase change of quartz at 870°C, the destruction of L centres occurs.

Isothermal decay experiments and quick heat experiments are applied to obtain the parameters of the OSL trap and the R centres. The lifetime of the OSL trap is found to be in a range from 10^8 to 10^9 years at 20°C. It is suggested that the OSL signal is stable enough for the dating of one million-year old samples. The OSL 325°C trap contributes an overwhelming majority of he OSL signal used in the OSL dating process. The lifetime of the R center is found to lie in the range from 1 to 30 ka at 20°C. The decay of R centres results in OSL sensitivity changes. The effect of sensitivity change must be considered in dating and dosimetry measurements.

Competition for electron between the OSL trap (325°C TL trap) and other traps is observed. The electron traps shallower than OSL trap compete with the OSL trap, but the traps deeper than the OSL trap do not.

Thesis abstract

Thesis title: Development and application of luminescence dating to quaternary sediments from China
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A three-stage single-aliquot additive-dose protocol (3-SAAD) for the equivalent dose (ED) determination of potassium feldspar is proposed. This procedure consists of 3 stages: preheat/measurement, dose/preheat/measurement and preheat/measurement; all the measurements for the equivalent dose determination are made on a single aliquot of feldspar. 3-SAAD provides a simple and efficient way of checking the appropriateness of preheat conditions during the ED estimation; the effects of the differences in mineralogy and luminescence properties from aliquot to aliquot are minimized. This procedure is also suitable for ED measurements on individual grains of feldspar.

An isochron technique is proposed, based on the EDs of grains (or aliquots) as a function of internal dose rate. This technique uses both quartz and feldspars grains (of the same size range), and takes advantage of the range in internal dose rates in these minerals to overcome uncertainties in the external dose rate. Even in the absence of independent age controls, the validity of the isochron ages can be assessed using the isochron equation. A significant improvement in dating uncertainty is demonstrated.

Assessment of the adequacy of bleaching of optical signals is very important for optical dating of sediments. A new method of assessing the bleaching of sedimentary feldspar grains is proposed, based on the difference in the bleaching rate between IRSL and TL signals. The size and scatter of the bleaching factors (normalized ratio of IRSL to TL) of grains (or aliquots) from a sample indicate the degree of bleaching. Well bleached grains can be identified by a relatively small bleaching factor, and relatively small scatter. All measurements required to estimate the ED and the degree of bleaching are carried out on the same grain (or aliquot). HF etching is necessary in optical dating of feldspar. Feldspars from different samples have different etching characteristics. For sedimentary feldspars from Hong Kong, it is found that 40 min etching with 10% HF at room temperature is appropriate.

Finally, three types of sediment from different areas are systemically dated using the optical techniques. They are colluvium sediments from Sham Wat debris lobe, Hong Kong, coastal deposits from area offshore of Hong Kong and dune sand samples from Horqin sandyland of northeastern China. Potential difficulties in optical dating of such sediments are discussed.