

## RADIATION DOSIMETRY USING NATURAL THULITE MINERAL BY TL TECHNIQUE.

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**Introduction:** The Brazilian soil is rich in mineral varieties such as silicates and many of them are sensitive to thermoluminescence (TL)<sup>[1]</sup>. The main objective of this project is to understand the behavior of the mineral thulite for use as TL dosimeters of ionizing radiation. This work presents TL results of thulite for high dose exposure and shows some properties of the mineral by X-ray fluorescence (XRF) and ray diffraction (XRD).

**Material and method:** The chemical formula of thulite is  $(Ca,Mn)_2Al_3(SiO_4)(Si_2O_7)O(OH)$ . The thulite mineral was crushed and sieved to retain grains between 80 and 180  $\mu m$  in size. Grains below 75  $\mu m$  were carried out for qualitative identification of crystalline phases of thulite through X-ray diffraction technique at the Crystallography Laboratory of the Institute of Physics-USP. Grains above 180  $\mu m$  were analyzed for the molecular composition of thulite by X-Ray fluorescence technique at Poli-USP. A batch of selected grains sieved from 75 to 180  $\mu m$  were heat treated at 500°C for 30 minutes. The batch was separated into 9 aliquots of approximately 40 mg and subsequently irradiated with  $\gamma$  rays at doses from 400 Gy to 5 kGy. The TL measurements were performed using a Harshaw 4500 TL reader with a heating rate of 4°C/s.

**Results:** Chemical analysis using X-ray fluorescence showed that the natural thulite contains the following main oxides: SiO<sub>2</sub> (43.4) mol%, Al<sub>2</sub>O<sub>3</sub> (23.9) mol%, CaO (23.2) mol%. Besides the main components, Fe<sub>2</sub>O<sub>3</sub> (1.65), MnO (0.21), MgO (0.51), Na<sub>2</sub>O (0.28) K<sub>2</sub>O (<0.28), SrO (0.19), TiO<sub>2</sub> (0.23), P<sub>2</sub>O<sub>5</sub> (<0.10) in mol%, are present in the crystal structure as impurities.

From the comparative analysis between the experimental diffractogram and the standard spectrum of different crystals, the diffraction peaks were identified mainly due to the presence of the crystalline phase of the zoisite with manganese. TL glow curves of thulite samples heat-treated at 500°C for 30 minutes and irradiated with  $\gamma$ -doses from 400 Gy to 5 kGy shows four peaks at temperatures 145, 165, 240 and 360 °C as can be seen in Figure 1.

**Conclusions:** The XRD and XRF analysis have shown that thulite have the zoisite crystal structure with manganese (hence the pink coloring) that is the basic composition of the main oxides corresponding to the natural thulite<sup>[2]</sup>. The TL glow curve of the samples heat-treated at 500°C for 30 minutes and irradiated with different  $\gamma$  doses present four peaks at 145, 165, 240 and 360°C. Dose response curves corresponding to 240 and 360°C show a linear behavior from 400 to 1 kGy after that calibration curves go into a saturation.

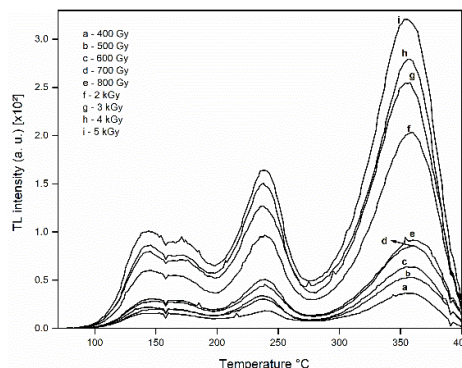


Figure 1: TL glow curves of natural thulite pre-annealed at 500 °C for 30 min and irradiated at several  $\gamma$  doses.

### References:

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2. G. Srinivasulu et al. "Electron microprobe analysis: optical and electron paramagnetic resonance studies on Mn-rich zoisite (thulite)." *Spectrochimica Acta Part A: Molecular Spectroscopy* 48.10 (1992): 1421-1425.