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Variation in the anomalous fading behavior of various luminescence signals from Durango apatite versus grain sizes; from micro to nano scale.

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Introduction:
Durango apatite is a geological, naturally occurring luminescent material that yields very intense anomalous fading (AF)[1]. Thus, it is ideal for investigating theoretical models, which are based on the quantum mechanical tunneling origin of the AF effect. The localized tunneling transition model[2] is based on tunneling recombination within randomly distributed donor-acceptor pairs. Since the donor-acceptor distance is of crucial importance for the model, the present work is aiming at affecting this distance distribution by gradually reducing the grain sizes up to the nano-scale.

Materials and methods:
The grains of the sample (natural crystal of Durango apatite) were divided into different size fractions: coarse grains 80-200μm and nano-scale grains, achieved by applying ball milling to the sample, for various periods (between 2-48hours). The grain size distribution was yielded using Electron Microscopy techniques. All samples were firstly annealed up to 700°C for 1h, irradiated and then stored under dark room conditions for different storage times. All luminescence measurements (TL, OSL and thermally assisted OSL; TA-OSL) were carried out using a Risø TL/OSL reader.

Results and conclusions:
In the case of TL and OSL signals, AF effect is ubiquitous for all apatite grain size fractions subjected to the present study, but seems to be independent of the grain size (Fig.1- OSL fading rate); similar results were also yielded for TL. Furthermore, similarly to the case of coarse grains, very intense TA-OSL signal is yielded. The signal emerges from VDT, since each TA-OSL measurement follows a TL measurement up to 500°C[3]. Nevertheless, the intensity is somehow decreased as the ball milling time increases; the fading rate obtained is getting decreased as the grain size fraction is also decreased (clearly highlighted in Fig.1- for ball milling duration of 48h, TA-OSL seems to be un-affected by AF).

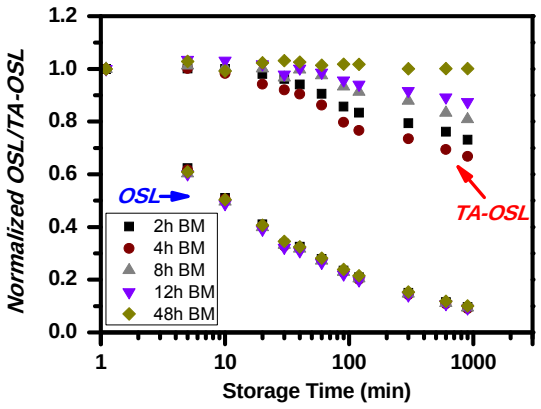

Fig.1: Fading rates for OSL and TA-OSL for various ball milling durations.

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