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650 nm Laser stimulated dating from Side Antique Theatre, Turkey

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HIGHLIGHTS

- Polymineral fine grain feldspar minerals were used for dating.
- Two different reading heads were used to determine equivalent doses.
- IR stimulated (880 nm) and laser stimulated (650 nm) dating results were compared.

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ABSTRACT

Samples were taken from the archeological excavation site, which was at the backs of the Side Antique Theatre. Samples were taken from under the base rock in this area. Polymineral fine grains were examined to determine the ages of the sediments. Samples gathered from the Side Antique Theatre were investigated through using the SAR method. Firstly, one part of the samples were evaluated by using conventional IRSL reading head model of (ELSEC-9010) which is infrared (880 ± 80 nm) stimulation source with Schott BG39 filter. The IRSL age dating with feldspar minerals, gives a number of overestimated or underestimated age values as a result. A new reading head was proposed with the following configuration attachments for overestimation of equivalent dose rates. Measurements were done with this newly designed red laser stimulating reading head which works with Elsec 9010 OSL age dating system. SAR measurements were performed by (650 ± 10 nm) red laser light source with two Schott BG3 filters. With usage of the new designed reading head; closer results were obtained in comparision with the Antique Theatre's expected age range. Fading rates were taken into consideration and these corrections were also handled for true age results.

1. Introduction

IRSL polymineral dating has great potential for better dose response in dating older sediments (Auclair et al., 2007). Conventional IRSL detection protocol uses a detection window centered on the blue and violet part of the spectrum. IRSL polymineral dating studies generally rely on the usage of the Schott BG39 filter with IR led groups. With infrared (880 ± 80 nm) stimulation (BG39 filter 310 680 nm) bandpass the filter passes luminescence light in UV and the blue spectrum range also rejects scattered infrared stimulation light. Many studies and fading correction models within the scope of IRSL dating yield reliable ages despite the (~25%) age overestimates. Dating of loess deposits in British Columbia using 4 ± 11 mm grains, Lian (1997) found that IRSL ages were higher than the expected age (based on 14C dates from ash layers); the author suggests that the presence of calcium carbonate may have resulted in poor bleaching of the IRSL signal at deposition. Another comparative study of IRSL with post-IR blue and blue stimulation of polymineral fine grain samples was done, and in each case a near-UV (U340 filters 290 370 nm) detection window was used. Despite the blue stimulation and post-IR blue stimulation results, IRSL equivalent dose values were found considerably higher than the expected ages (Banerjee et al., 2001).

Firstly, OSL signals from feldspars were obtained with 514 nm light from a laser (Huntley et al., 1985). The luminescence spectra obtained in the 400–620 nm range for some natural feldspars under 514.5 and 632.8 nm illumination are given (Huntley et al., 1989). A number of feldspar emission bands were reported. These emission bands included 280, 330, 410, 560 and 700 nm wavelengths (Krbetschek et al., 1996). Far-red emission is a prominent luminescence in many feldspars (Krbetschek et al., 1997). Also, the existence of far-red IRSL emissions (665–740 nm) in feldspar loess samples have been reported (Lai et al., 2003).

In this study, extension polymineral fine grained samples were stimulated by 650 nm laser light source rejecting scattered laser

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light, with two Schott BG3 filters. With this new experimental arrangement, the results were also evaluated with a wider wavelength range. The Schott BG3 filter usage comprised of most emission wavelengths, and also the distinctively far red 700 nm wavelength. Also in all these studies, the measuring anomalous fading rate is significant (Aitken, 1985; Auclair et al., 2003). In order to correct the age results, fading rates were also calculated.

The archeological site in Side (Antalya, Turkey), is one of the oldest settlements in Anatolia, having been established before the 7th century BC. Archeologists are interested in the age of collected samples (SDSAR1 to SDSAR12). The study can be summarized by saying the overestimated ED values, which were obtained by a conventional (ELSEC-9010) IRSL reading head, were revaluated with a newly designed 650 nm red laser stimulated reading head.

2. Experimental procedures

2.1. Apparatus

The apparatus used in this study, an Optical Dating System, (ELSEC 9010 Littlemore Scientific Eng.) was developed by (Spooner et al., 1990). A basic luminescence reader incorporates an infrared light emitting diodes (880 ± 80 nm) that runs at 40 mA, giving a power of approximately 30 mW/cm². Light detection was accomplished via a bialkali photocathode Thorn EMI 9235QA photomultiplier tube, with a Schott BG39 filter (310 680 nm) combination. The spectral sensing range of the aforementioned photomultiplier tube varies from 165 nm to 630 nm. If the technique uses an infrared light source as a stimulation source, it is called Infrared Stimulated

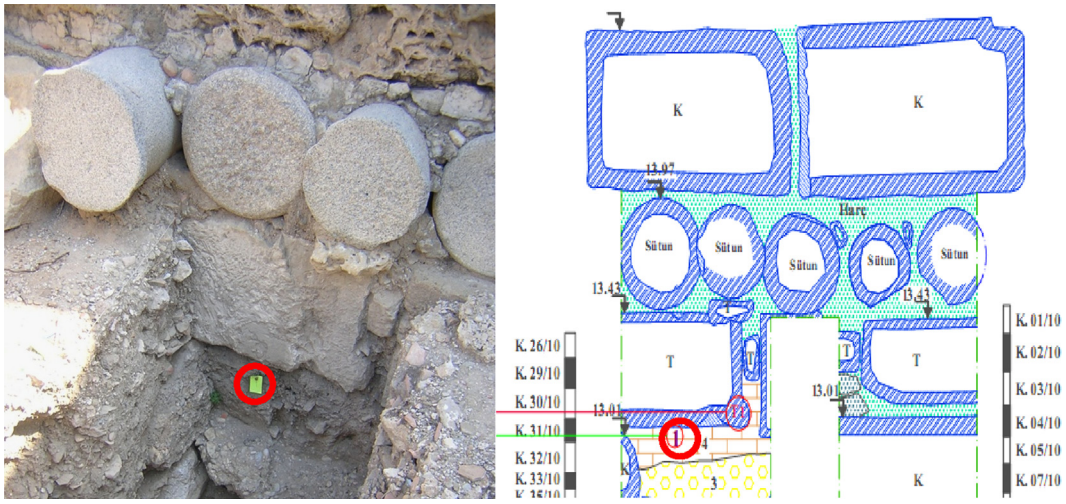

Fig. 1. Digging site picture was marked to indicate the sampling point and excavation site's diagram.

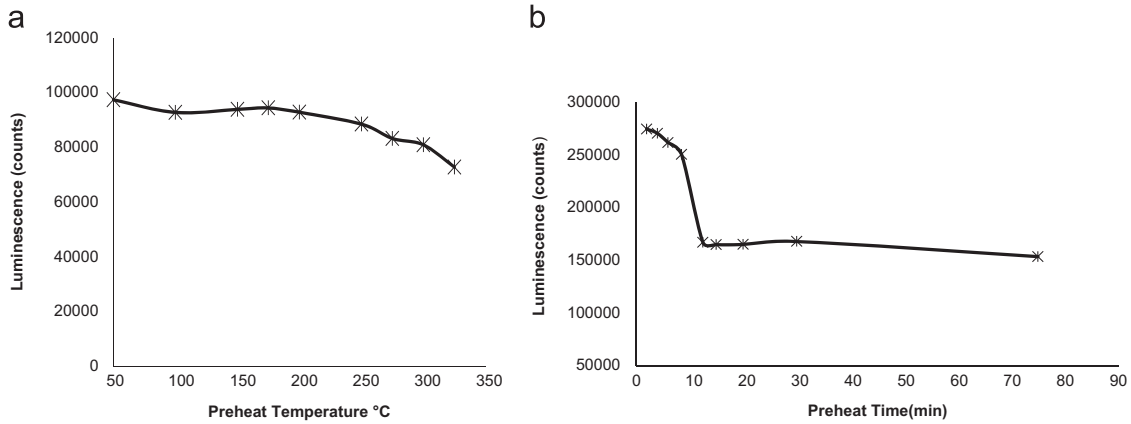

Fig. 2. (a) The sample's luminescence counts versus the preheat temperature. (b) The sample's luminescence counts versus the preheat time. The preheat temperature of 165 °C and preheat time of 25 min were defined with these graphics.

Table 1
Annual dose rates were obtained by a high purity coaxial-type ORTEC germanium dedector.

Procedure	*a* value	U (ppm)	Th (ppm)	K (%)	ACD[a] (mGy/a)	*W*[b]	Annual dose (mGy/a)
SAR(R9110^{RL})	0.15	2.57 ± 0.11	5.33 ± 0.18	0.75 ± 0.03	0.16	0.25 ± 0.005	3.1
SAR(9235QA^{IR})	0.15	2.57 ± 0.11	5.33 ± 0.18	0.75 ± 0.03	0.16	0.25 ± 0.005	3.1

[a] Annual cosmic dose.
[b] Saturation water content RL: Red laser stimulated, IR: Infrared stimulated.