First paleosecular variation intensity curve for the last 4k years for Central Asia

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1. Introduction

Thanks to recent archaeomagnetic studies, it has been observed that the intensity of the magnetic field undergoes abrupt variations in different eras and regions of the planet. The aim of this work is twofold: first, to provide the first high-quality archaeointensity data for the 2nd millennium BC in Central Asia. For this purpose, 76 pottery sherds, collected from three different archaeological sites in Uzbekistan were analysed by Thellier-Thellier method. The second objective is to present the first paleosecular variation (PSV) intensity curve for the last 4000 years, which allows a detailed understanding of the magnetic intensity behaviour in Central Asia.

2. Archaeological Context

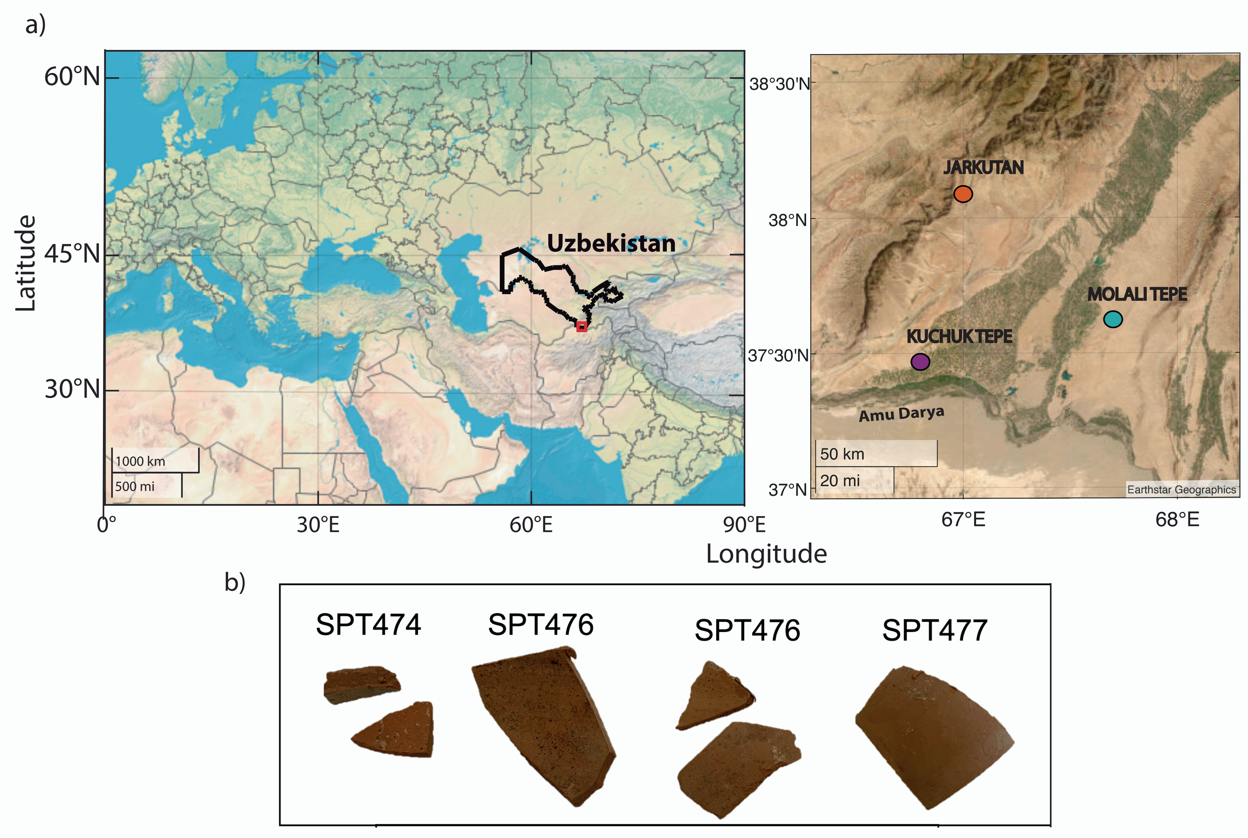

Fig 1. a) Map with location of the archaeological sites studied. b) Studied archaeological material.

We analysed 76 ceramic fragments, dated by archeological and historical constraints and radiocarbon analysis, coming from three archeological sites:

1. Molali Tepe: 1600 - 1400 BC. The ceramics were contextualised from archelogical excavations and dated using the 14C method.

2. Jarkutan: 2000 -1400 BC. Contextualised ceramics from archeological excavations, sampled at the Termez Museum.

3. Kuchuk Tepe: 900 - 330 BC. The ceramics were collected during a surface archeological survey of the site.

3. Rock Magnetism Experiments

The majority of Lowrie Tests indicate the presence of minerals with low coercivity and Curie Temperatures in the range of 350 to 600ºC (Fig. 2a). In certain instances (Fig. 2b), minerals with high coercivity contribute to a notable portion of the magnetisation.

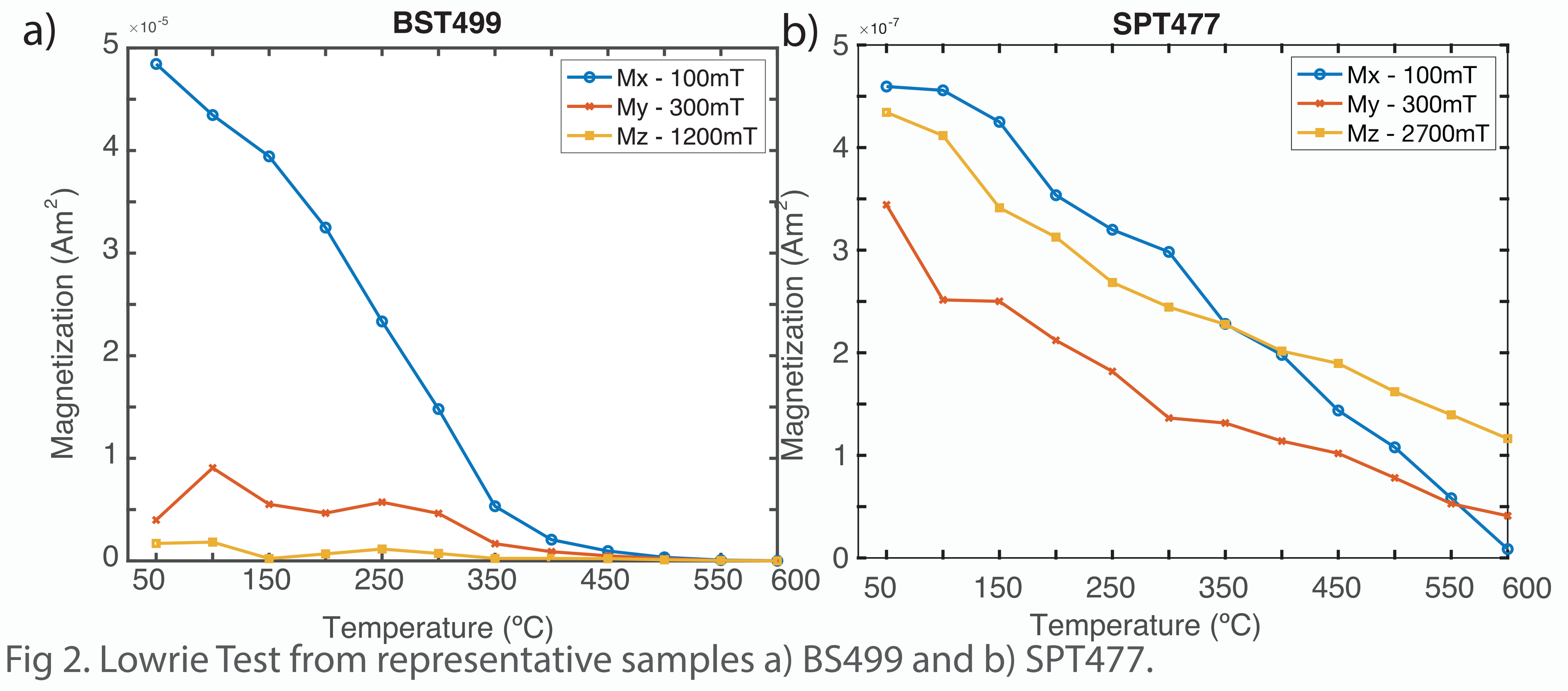

Fig 2. Lowrie Test from representative samples a) BS499 and b) SPT477.

Thermomagnetic curves indicate Curie Temperatures between 250 and 700°C (Fig. 3), which suggest the presence of magnetite and titano-magnetite with varying Ti contents.

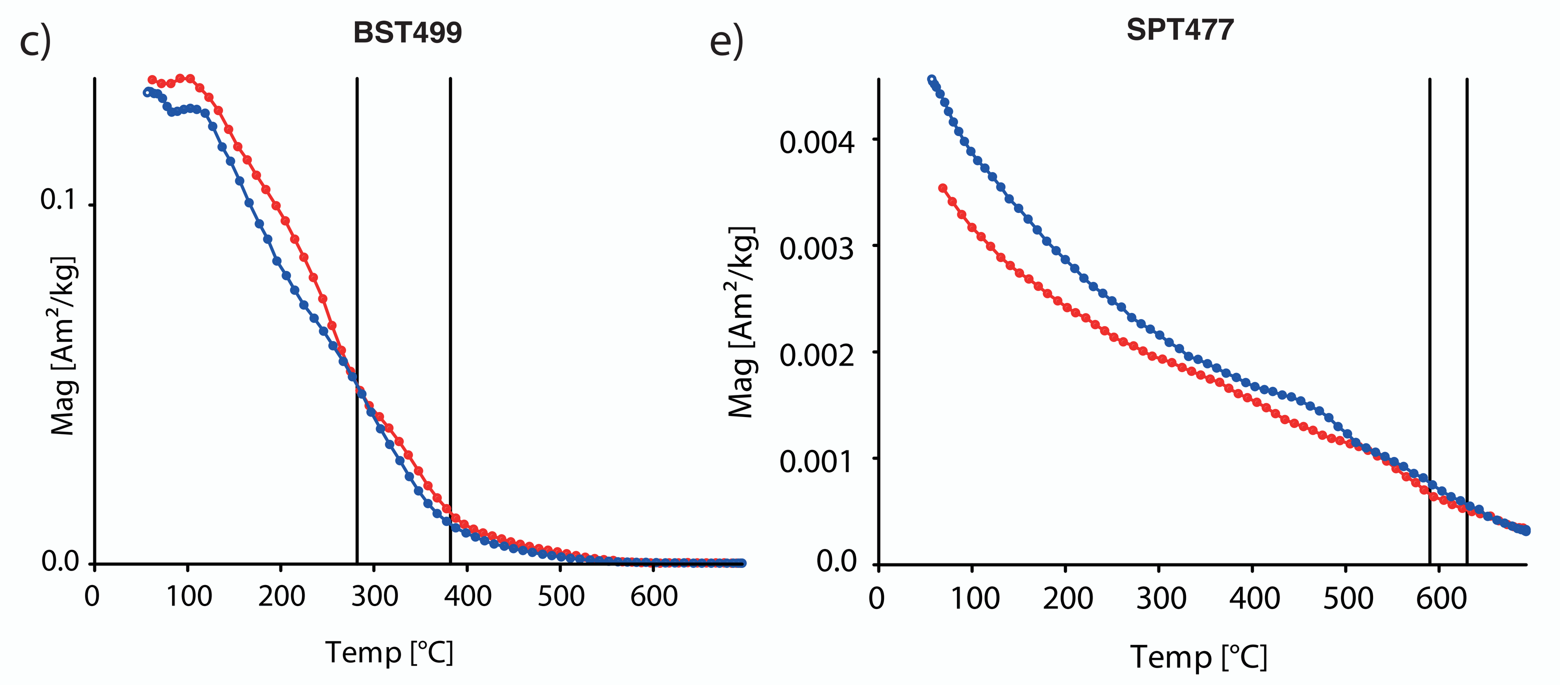

Fig 3. Thermomagnetic curves from representative samples a) BS499 and b) SPT477.

4. Paleointensity Experiments

We applied the classical Thellier method (Thellier & Thellier, 1959) including pTRM checks, TRM anisotropy and cooling rate corrections to 208 specimens corresponding to 76 pottery fragments. 133 specimens correspond to well-defined single components of magnetization (Fig. 4).

The TRM anisotropy effect is high for the majority of the samples, being different in sister specimens from the same fragment. The results confirm the crucial need to properly determine the TRM tensor when studying highly anisotropic ceramic materials, and invalidate previous archeointensities data from Central Asial for which this effect was not corrected at the specimen level (see Genevey et al. 2008 and references therein).

Cooling rate correction was also performed at the specimen level. Finally, to ensure the reliability of the paleointensity data, the quality criteria used are : f > 50 %; q > 10; N > 5; MAD < 5º; DANG < 5º. From these criteria, 51 of the 69 well-defined single components were retained.

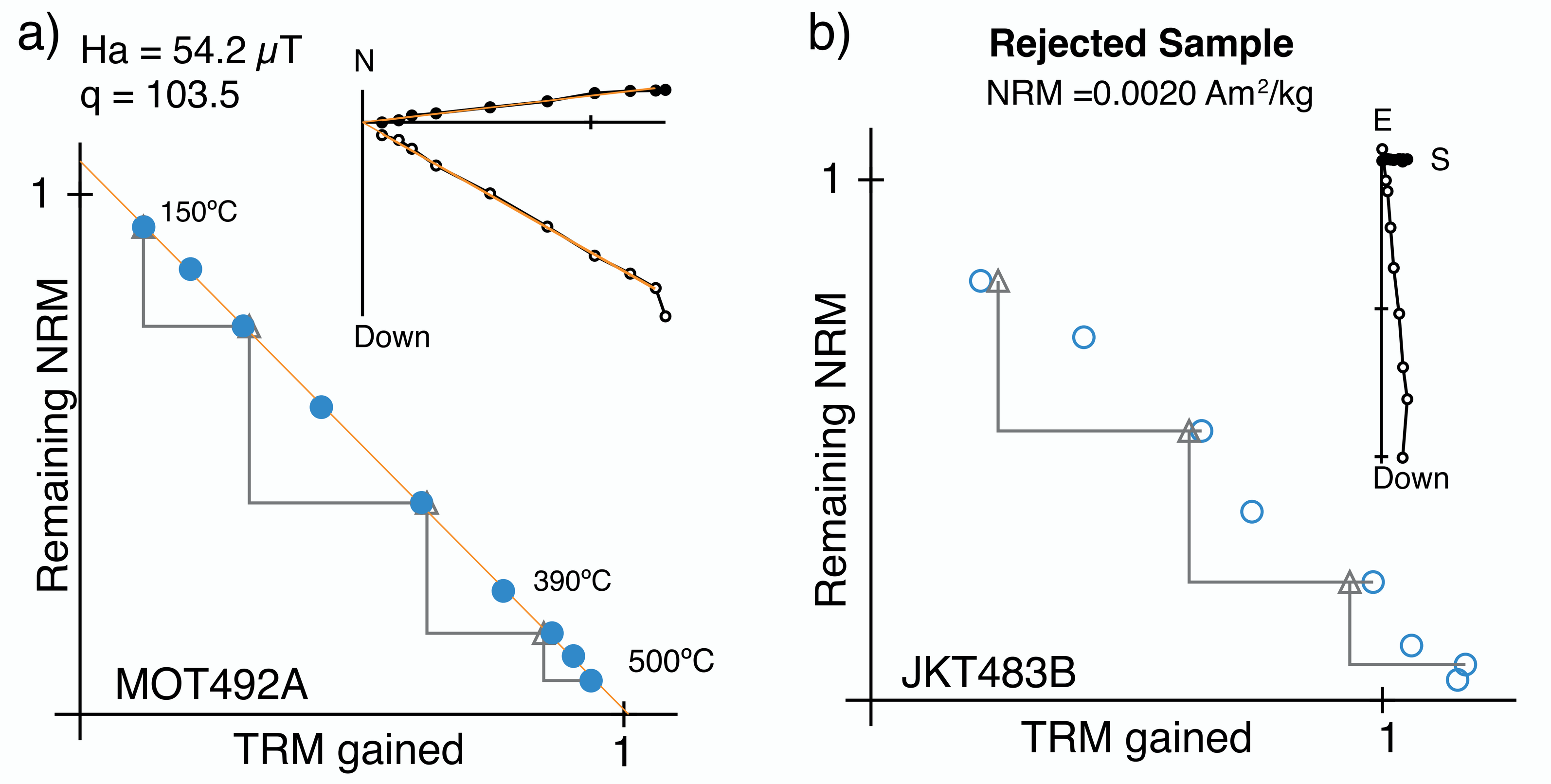

Fig 4. Arai and Zijderveld diagrams of representative samples a) accepted and b) rejected.

5. Paleosecular Variation Curve

PSVC Construction:

- The method used in the creation of the PSVC involves generating a set of 5,000 PSVCs using the bootstrap technique.
- To ensure the robustness of the PSVC, potential outliers have been identified and removed.
- In order to construct the PSVC, we have chosen to categorise the data into three distinct groups, with each group assigned a specific weight according to a several specific criteria.

Main Features:

- Increasing intensity between 1900 BC and 1400 BC.
- High intensities from 900 BC to 400 BC.
- Rapid drop in intensity followed by an increase, with a minimum around the change of era.
- Progressive intensity decrease during the last centuries.

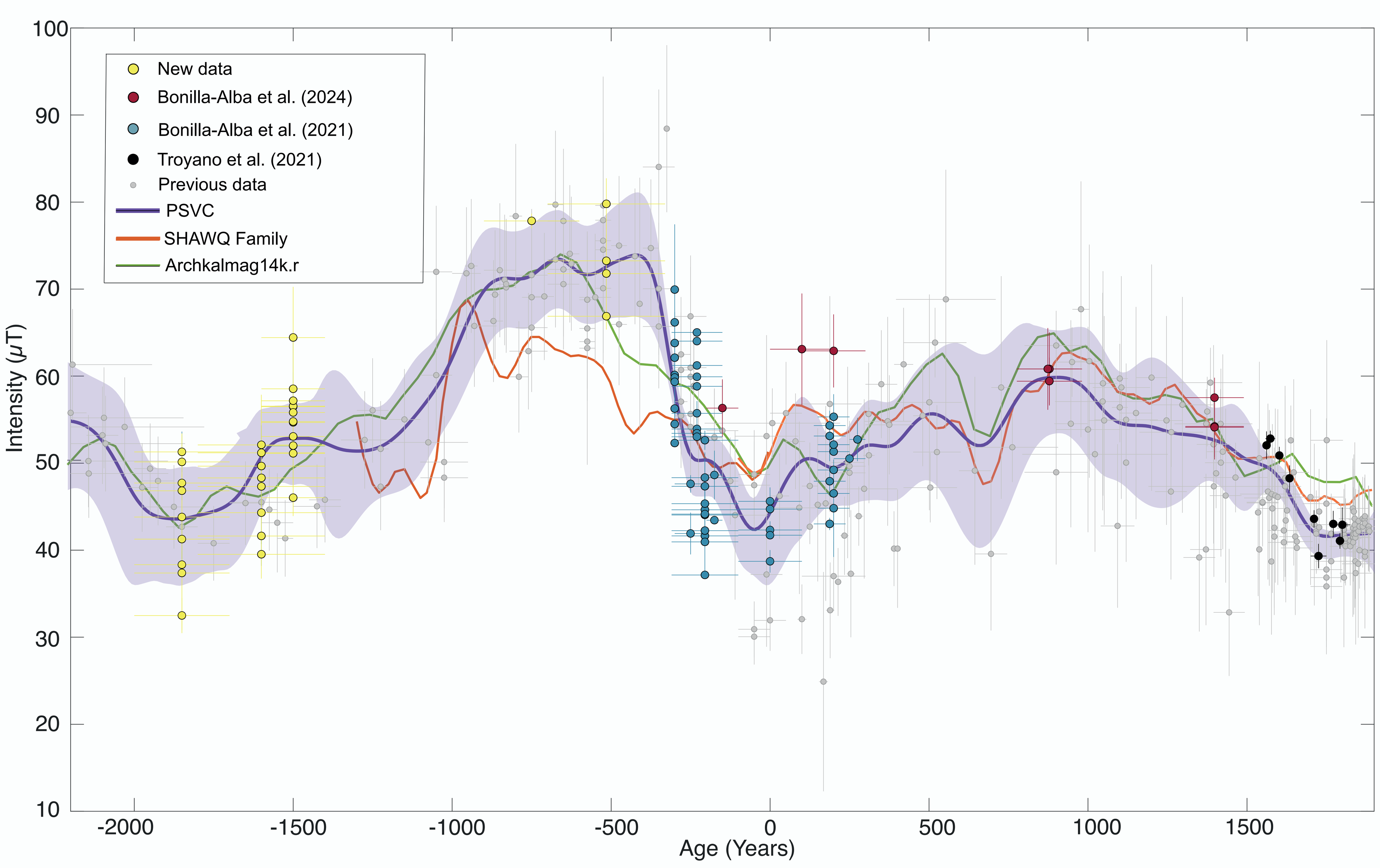

Fig 5. New archaeointensity data together with previous data and the proposed new PSVC for Central Asia. The predictions of the SHAWQ family of models (Campuzano et al., 2019, Osete et al., 2020) in orange and the ArchKalmag14k.r model (Schanner et al., 2022) in green.

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