Paleoseismic Record of Three Holocene Earthquakes Rupturing the Issyk-Ata Fault near Bishkek, North Kyrgyzstan

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1 INTRODUCTION

In areas undergoing low strain accumulation with long recurrence intervals the evaluation of thrust paleoearthquakes and associated fault scarps is often hampered by the size of their cumulative fault scarps and interaction with sedimentary processes during interseismic periods. To improve mapset potential sites in continental seismic zones a combination of instrumental records with extended archives of historic and paleoearthquakes.

We present a paleoseismological study from one site (Belek) along the Issyk-Ata fault located east of the A.D. 1885 epicentral area.

Figure 1. General geologic overview of Kyrgyzstan (modified after Bulien et al. 2003 and Macaulay et al. 2013)

2 BACKGROUND

The Issyk-Ata fault is situated south of Bishkek, the Kyrgyz capital and defines the northern most deformation front of the Kyrgyz Range, Central Tian Shan.

- 120-km-long reverse to thrust fault, the south dipping, extends in east-west direction [1, 5].
- Left unruptured for almost its entire extent during a sequence of large magnitude earthquakes (M > 6.9) in 19th - 20th century [3, 4].
- The sequence initiating A.D. 1885 (Belovodskoe; M = 6.9) earthquake ruptured at the western most tip of the Issyk-Ata fault.

Figure 2. Digital topography (ALOS Global Digital Surface Model, ALOS2) with Earthquake distribution in the northern Tian Shan. Green star indicates study site. Circles include historic (dark) and recent (light) earthquakes (ComCat, USGS). Intensity isolines indicate areas of associated earthquake intensities (MSK64 scale), after Patyniak et al. (2017, BSSA, accepted).

3 PALEOSEISMIC INTERPRETATION

The trench at the Belek site presents good evidence for at least 3 earthquakes that ruptured along two fault zones (in F1 and F2).

- The thrust sense of motion is reflected by a carbonate-cemented unit (unit 9) that was further used as an offset marker.
- Scarp-derived colluvial wedges can be identified in the footwall (units 1, 3, and 6). The colluvial wedges are interbedded with mixed eolian and wash deposits.
- Colluvium (unit 3) and wash deposit (unit 4) are cut by a fissure (unit 5) and filled with material of unit 6.

Figure 3. Stratigraphic interpretation and photolog of the west wall (after Patyniak et al. 2017, BSSA, accepted). Fissure and alluvial strata (units 8-11) in the hanging wall overthrust a massive loose deposit (unit 2).

Figure 4. Carbonate coating at the underside of clasts used for relative event chronology and absolute time constraints with U-series dating. Boxes in the trench wall indicate the close-up images shown below with three different zones of clast orientation and the carbonate coating, respectively.

4 RESULTS

Our study yielded two principal results: First, the study extends the regional historic and paleoseismic record. Second, the documented rupture events along the Issyk-Ata fault suggest that this fault was not affected in its entirety; instead, the events indicate segmented rupture behavior.

Figure 5. Probabilistically modeled earthquake timing for all three events described for the Belek site using OxCal v4.2 with the IntCal13 atmospheric curve [6]. The model is based on the combination of calibrated ¹³C, IRSL and Uranium-series ages (after Patyniak et al. 2017, BSSA, accepted).

Figure 6. Palaeomagnitudes for the Belek site with highest peaks between M6.5-7. The estimates are based on individual average displacements d and their min/max values (insets) of the most recent (MRE) and penultimate event (PE). Late Pleistocene slip rate for the Belek site empirically estimated based on fan age and cumulative fault scarp offset from field observations. The open source Python tool Slip Rate calculator, v. 0.1.2. Zenodo (after Patyniak et al. 2017, BSSA, accepted).

CONCLUSIONS

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REFERENCES