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Supplement of

New paleoseismological and morphotectonic investigations along the 2018 surface ruptures of the Fiandaca Fault, eastern flank of Etna volcano (Italy)

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S1. Historical earthquakes and surface faulting events

Table S1 summarizes the information about the earthquakes that mentioned in section 3.2.

Table S1: Historical known earthquakes along the Mt. Etna E flank around the Fiandaca Fault with the corresponding fault activated (modified after Azzaro, 1999; Azzaro et al., 2022; Tringali et al., 2023). Intensity and magnitude from CPTI (Rovida et al. 2020) and Azzaro and Castelli (2015). SR: surface ruptures evidence. SRL: surface rupture length. Slip: the slip amount as heave (h), throw (t) and dextral strike-slip (ss). Faults: faults involved coded as follow: FIA: Fiandaca; FLE: Fleri; CAT: Aci Catena.

d m y	*Time (UTC)*	I_{EMS}	*Mw*	*Epicentral location*	*SR*	*SRL (km)*	*Faults*	*Slip (cm)*	*References*
28/06/1329	22:00	7-8	4.03	E and S flank	yes	-	-	-	Nicolaus Specialis, 1791
13/07/1766	-	4-5	-	E flank	?	-	-	-	Recupero, 1815
--/04/1809	-	HF	-	NE and E flank	yes	-	-	-	Ferrara, 1810 and 1818
26/08/1819	03:30	4-5	-	Acireale	?	-	-	-	Maravigna, 1819
28/08/1829	-	F	-	Surroundings of Acireale	?	-	-	-	Alessi, 1829-1835
5 and 9/05/1831	-	HF	-	Acireale	?	-	-	-	Alessi, 1829-1835
07/01/1875	23:45	7	3.75	Zerbate		1.5	FIA	-	De Rossi, 1875
08/08/1894	05:16	8-9	4.6	Mazzasette-Fleri-Pennisi-Zerbate	yes	7-8	FLE, FIA, CAT	at least 8-15 (t)	Platania & Platania, 1894; Riccò, 1894; Platania, 1915
07/12/1907	21:28	7	4.0	Fiandaca	yes	2.5	FIA	at least 4 (h)	Platania, 1908
07/05/1914	17:36	6	3.2	Fiandaca	yes	2	FIA	-	Platania, 1915
07/05/1914	20:59	6	3.2	Fossa dell'Acqua	Yes	2	FIA	-	Platania, 1915
03/08/1931	21:12	6-7	3.5	Fiandaca	yes	-	FIA	-	Cavasino, 1935; Imbò, 1935
27/03/1941	05:20	6-7	3.5	Fleri	?	-	FLE	-	Ponte, 1941
17/06/1984	16:51	5-6	2.9	Santa Maria la Stella	yes	-	FIA	-	Patanè and Imposa, 1995
19/06/1984	15:19	7	3.96	Fiandaca	yes	1.6	FIA	2-3 (h) 20 (t) 1 (ss)	Benina et al., 1984; Patanè and Imposa, 1995
25/10/1984	01:11	8	4.4	Fleri	yes	1.7	FLE	-	Villari, 1984; Patanè and Imposa, 1995
11/11/1997	07:27	5-6	3.38	Santa Maria la Stella	yes	0.9	FIA	1.5 (h) 0.3 (t)	Azzaro, 1999; This study
19/04/2005		5-6	2.2	C.da Cubisia (Aci Catena)	yes	1	FIA	2-3 (h)	Azzaro et al., 2006
25/09/2014		5-6	3.3	Santa Maria la Stella	yes	1	FIA	1-2 (h)	Azzaro et al., 2020
26/12/2018		8	5.0	Fleri-Pennisi-Fiandaca	yes	8	FLE, FIA, CAT	120 (h) 45 (t) 30 (ss)	Azzaro et al., 2022; Civico et al., 2019; Tringali et al., 2023

Below is a description of the earthquakes with further information regarding surface faulting, which is a summary of the data already published. The only substantial addition concerns the 1997 earthquake surface faulting information.

The earthquakes that occurred before 1875, except for the 1329 event, were felt in Acireale and its surroundings (Azzaro and Castelli, 2015 and references therein); therefore the precise epicenter location is uncertain. In some cases, also date and time is uncertain.

The seismic events in 1875 (De Rossi, 1875), 1907 (Platania, 1908), 7 May 1914 (Sabatini, 1913-14; Platania, 1915), 1931 (Cavasino, 1935, Imbò, 1935), 17 and 19 June 1984 (Benina et al., 1984; Villari, 1984; Patanè & Imposa, 1995), 1997 (Azzaro, 1999) and 2014 (Azzaro et al., 2020), all occurred along FIA, between Pennisi and Santa Maria La Stella. These earthquakes were characterized by surface ruptures represented by extensional cracks with a minor dextral component and throws up to 20 cm. Several historic earthquakes have as epicentral location Zerbate that is a locality between Santa Maria la Stella and Fiandaca. Zerbate was a populated small village that has not been rebuilt after the 1907 earthquake.

The 1875 earthquakes occurred between Fiandaca and the locality Fossa dell'Acqua, where the village Zerbate was located (De Rossi, 1875). The 1875 earthquake was characterized by a surface rupture length of 1,5 km and offset of few centimetres along ruptures with evident relative subsidence of one of the two sides (De Rossi, 1875).

The 8 August 1894 earthquake with its epicentre in Mazzasette, between Fleri and Fiandaca, was associated with 4-5 km of surface rupture length with extensional and oblique dextral ground cracks (Azzaro, 1999; Baratta, 1894; Platania & Platania, 1894; Riccò, 1894). Nevertheless, the information provided by Platania (1908; 1915) and a 1894 newspaper (La Tribuna, 1894) allows to extend the rupture at least to 7-8 km. The surface faulting length and the macroseismic data confirms that the 1894 and 2018 earthquakes are very similar as already discussed by Azzaro et al. (2022) and Tringali et al., (2023).

On May 7, 1914, a sequence of two earthquakes shook the area of Fiandaca, Piano D'Api and Fossa dell'Acqua. Platania (1915) associated the earthquakes to the central and southern termination of FIA because of the well evident surface ruptures for at least 2 km in Fiandaca and Fossa dell'Acqua. These earthquakes were part of a seismic swarm, which was involving the TFS, preceding the main shock. The mainshock occurred along the Linera Fault (LIN in Fig. 1a) the day after (May 8, 1914; Platania, 1915). The May 8, 1914, Linera earthquake caused relevant damages with a maximum EMS intensity of 9-10 (Azzaro, 1999; Rovida et al., 2021), and extensive surface faulting (Platania, 1915; Azzaro, 1999 and references therein). The Linera earthquake may have attracted so much attention that smaller events were overlooked.

The earthquakes occurred on 17 and 19 June 1984, were associated with surface ruptures for a total length of 1,6 km and throw up to 20 cm in the southern sector of FIA.

On November 11, 1997, two earthquakes occurred during the day along southern termination of FIA where very well evident creep phenomena are present. The earthquakes produced the reactivation of pre-existing creep ruptures that accumulated a maximum heave of 1.5 cm and 0.3 cm of throw (Fig. S1). The accurate measures were recorded by two crack meters installed in 1995 and positioned along the southern sector of FIA on damaged walls delimiting a road (Fig. S1e and f). In the following days, some creep phenomena remobilised the ground ruptures with new

opening observed in November 11 (Fig. S1a). After the creep, the crack meter accumulated 2.2 cm of heave, 0.6 cm of throw and 1 cm of right lateral displacement, until they broke down on November 15.

The 2014 earthquake occurred along the same sector of 1997. The 1997 and 2014 earthquakes were characterized by ~1 km of surface faulting (Azzaro, 1999; Azzaro et al., 2020) with offset of few centimetres (Azzaro, 2020). Finally, the earthquake occurred in 2005 interested the southernmost sector of FIA producing centimetric offset along pre-existing creep surface ruptures (Azzaro et al., 2006).

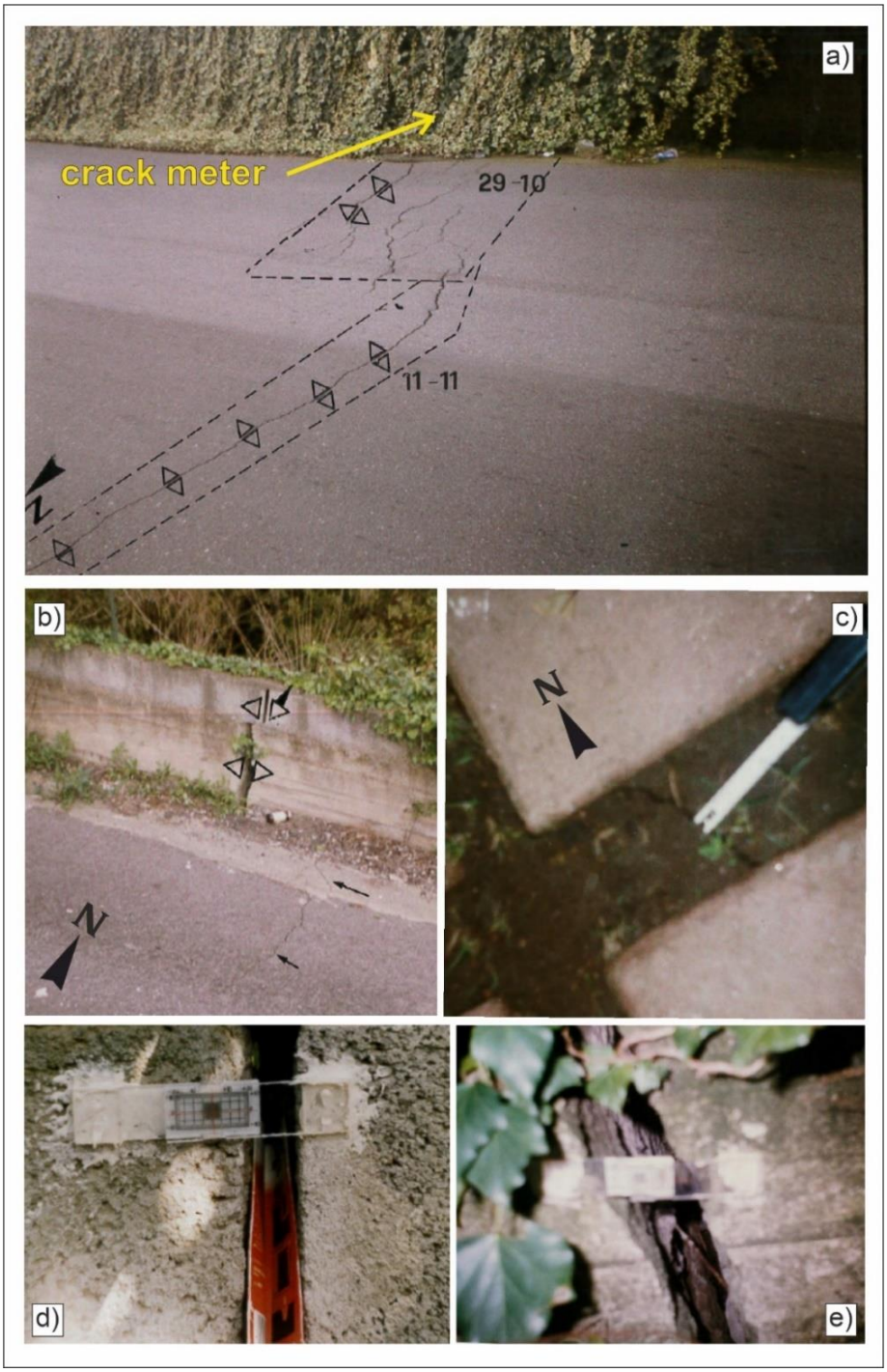

Figure S1: Field photos taken after the earthquake occurred in 1997: a) coseismic surface ruptures of October 29 and aseismic creep ruptures observed on November 11; b) coseismic ruptures along a road taken just few metres to the N of the (a) photo; c) coseismic rupture on soil in private courtyard taken just few metres to the N of the (b) photo; d) crack meters installed few metres to the N of (b) photo; e) crack meter indicated in (a) photo.

S2. Methods: sediment elemental composition

We collected sediment samples, named WFIA and EFIA, from the East and West walls of the FIA1 trench in U2 using polyethylene bags, keeping them away from the light and temperature changes. Elemental chemistry composition was determined via highly sensitive analytical Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) technique. Samples were previously dried at 40°C for 12 h and homogenized and pulverized in an agate mill. Subsequently, 250 mg of sample underwent microwave-assisted digestion (ETHOS One, Milestone MLS, USA) using aqua regia (EPA, Method 3051) and HF to dissolve the silica recalcitrant fraction (Pinna et al., 2022). Ultrapure nitric and hydrochloric acid solutions were obtained by sub-boiling distillation of Carlo Erba (Italy) reagents 65% volume solution, using Milestone (USA) duoPUR. The digested solutions were then diluted with ultrapure water (18.2 MΩcm resistivity) and analysed using Rh as internal standard. The results are reported in Table S2 as mg of the extracted element by a unit of volume (kg) of dry sediment.

Table S2: Sediment chemical composition from samples collected in U2.

	mg/kg																							
	Li	**Be**	**Na**	**Mg**	**Al**	**K**	**Ca**	**Ti**	**Cr**	**Mn**	**Fe**	**Ni**	**Cu**	**Zn**	**As**	**Se**	**Rb**	**Sr**	**Zr**	**Ag**	**Cd**	**Sn**	**Ba**	**Pb**
WFIA	0,506	0,053	182,041	467,145	2240,924	81,698	560,991	181,538	0,559	35,589	2138,525	0,739	7,114	3,769	0,177	0,097	0,707	20,244	3,780	0,002	0,006	0,020	11,948	0,612
EFIA	0,497	0,053	185,503	442,501	2245,885	79,494	574,049	164,653	0,539	31,078	2118,228	0,543	8,604	3,041	0,151	0,097	0,654	20,747	4,238	0,002	0,004	0,021	12,314	0,513

The highlighted chemical composition shows similar values, confirming that the collected samples are from the same horizon identified in the U2.

S3. Geological cross sections along the Fiandaca Fault

Fig. S2 shows the trace of the 10 geological cross sections; Figs. S3-S5 show the geological cross sections.

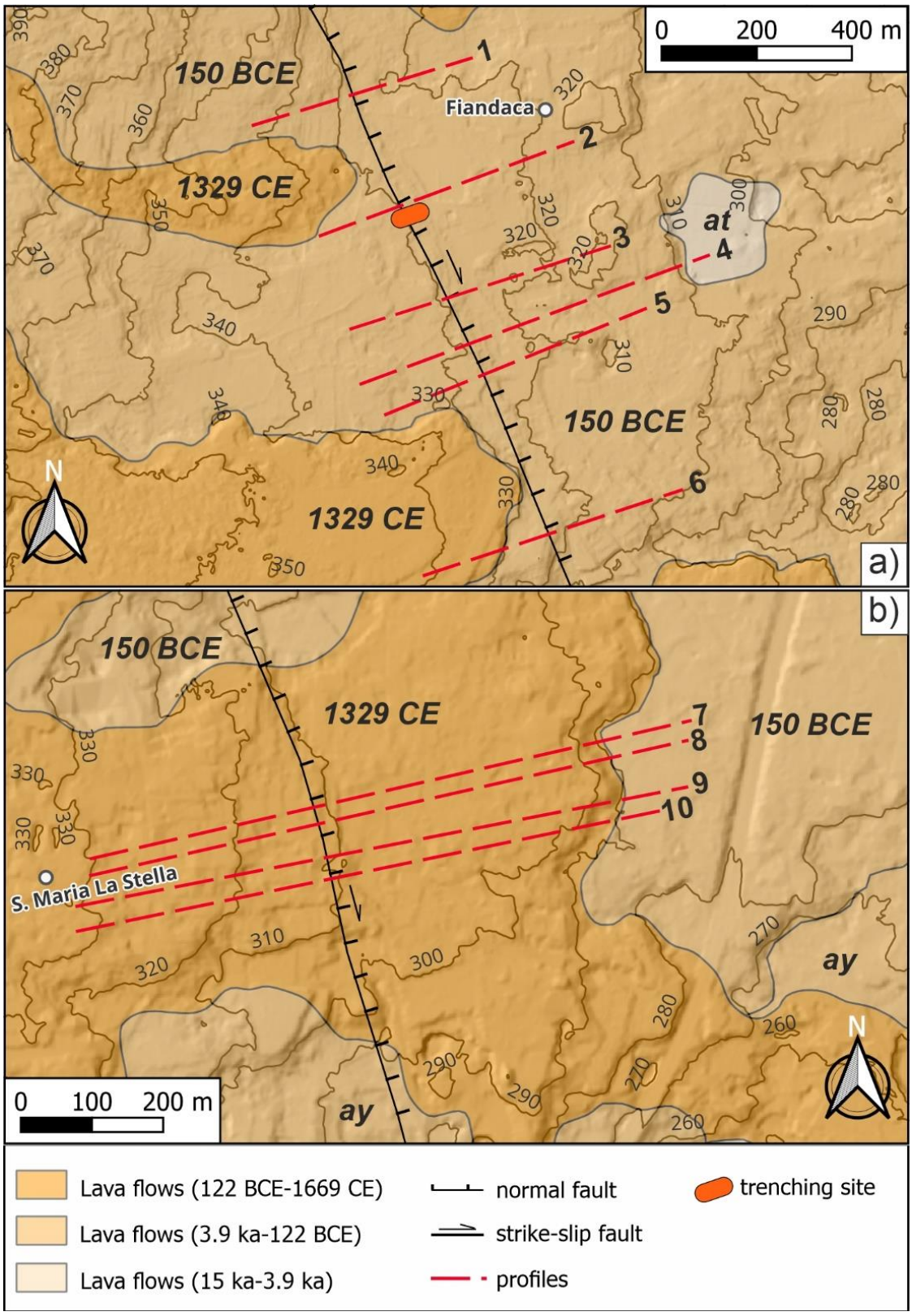

Figure S2: Geological maps with capable faults (modified after Branca et al., 2011; Azzaro et al., 2012; Barreca et al., 2013; ITHACA Working group, 2019) showing profiles along the Fiandaca Fault. Lava flows chronologically labelled *ay:* Piano d'Api (3.9 ka); *at*: Aci Platani (15 ka).

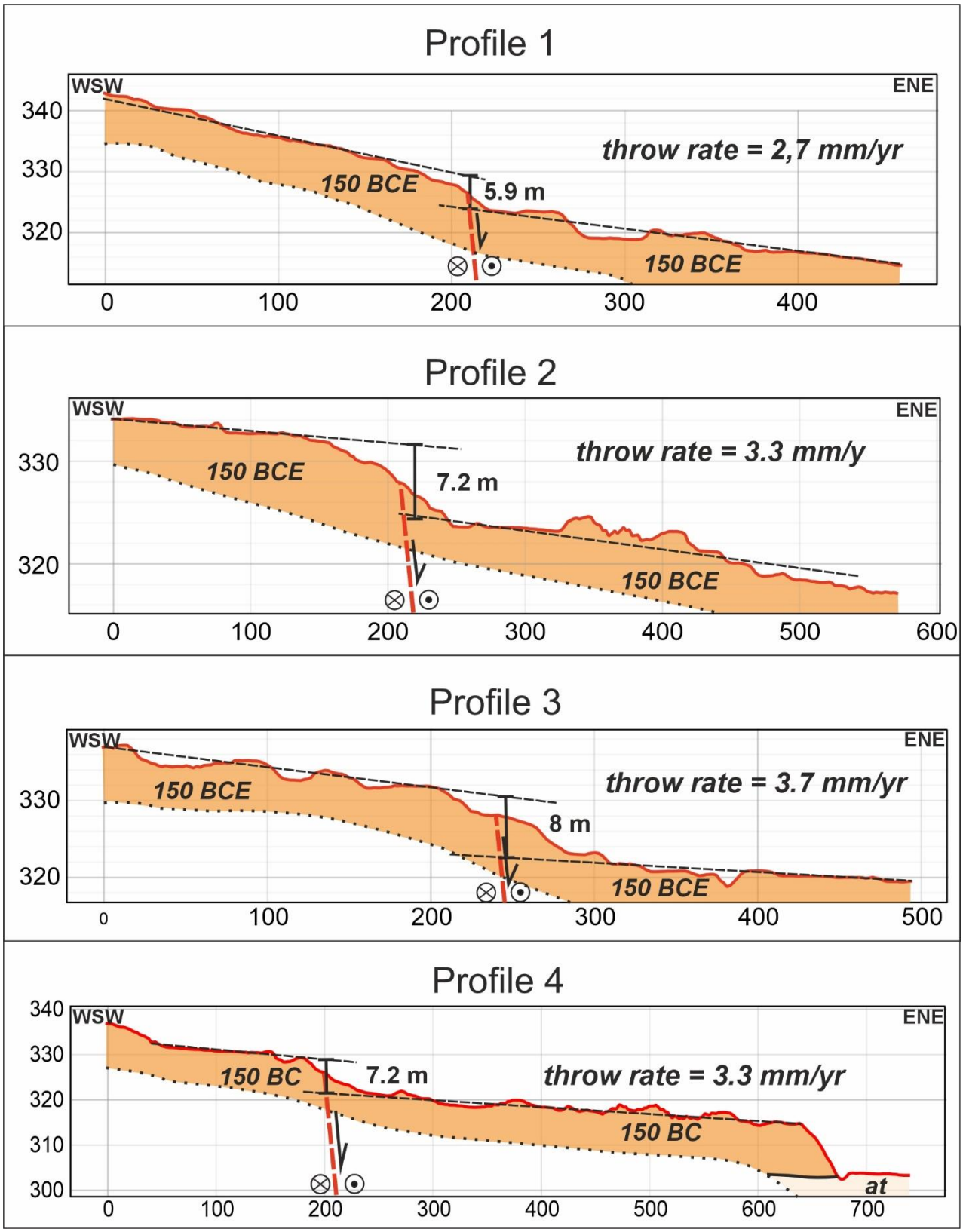

Figure S3: Geological profiles 1-4 along the Fiandaca Fault (FIA); *at*: Aci Platani lava flow (15 ka).

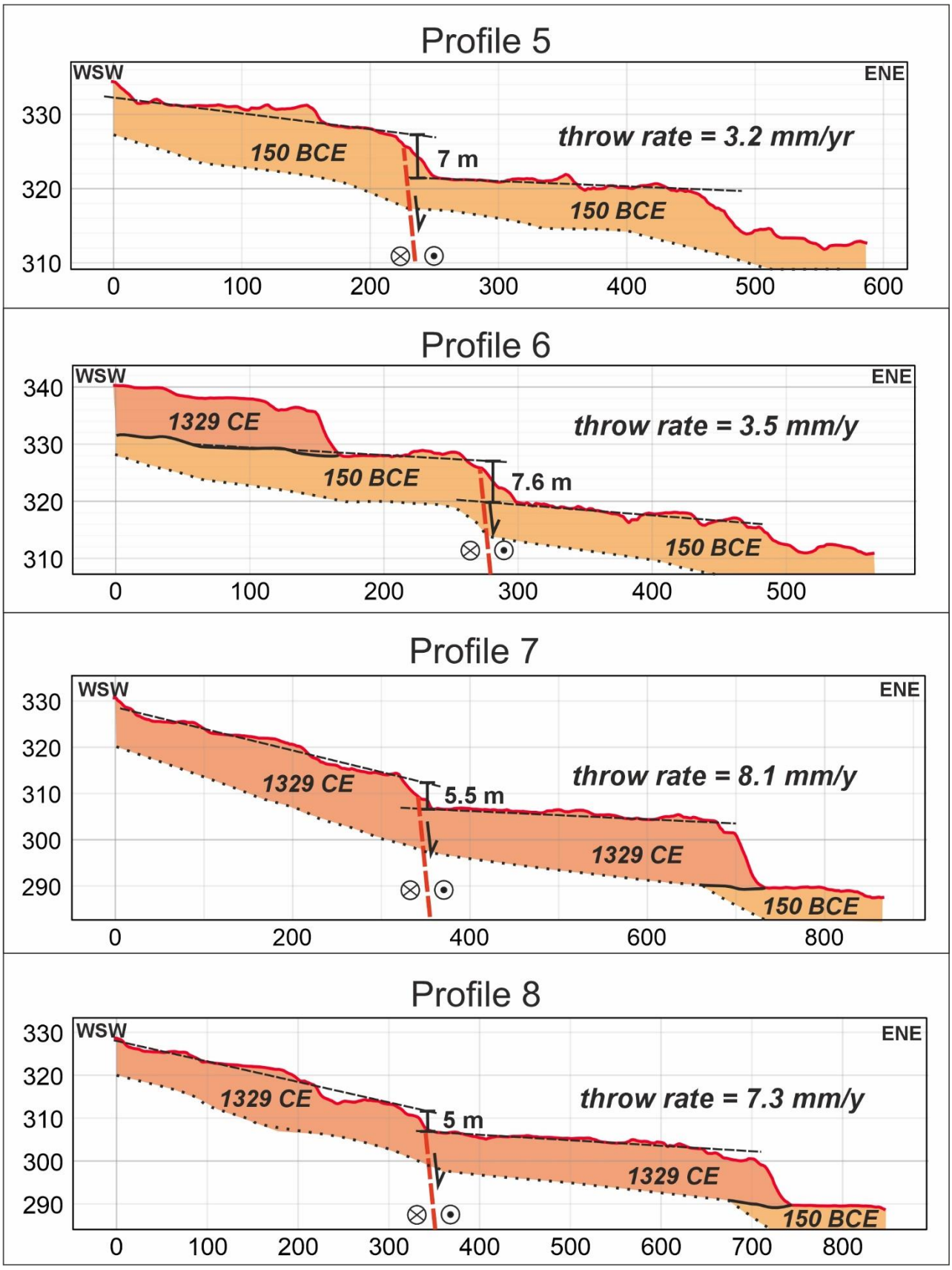

Figure S4: Geological profiles 5-8 along the Fiandaca Fault (FIA).

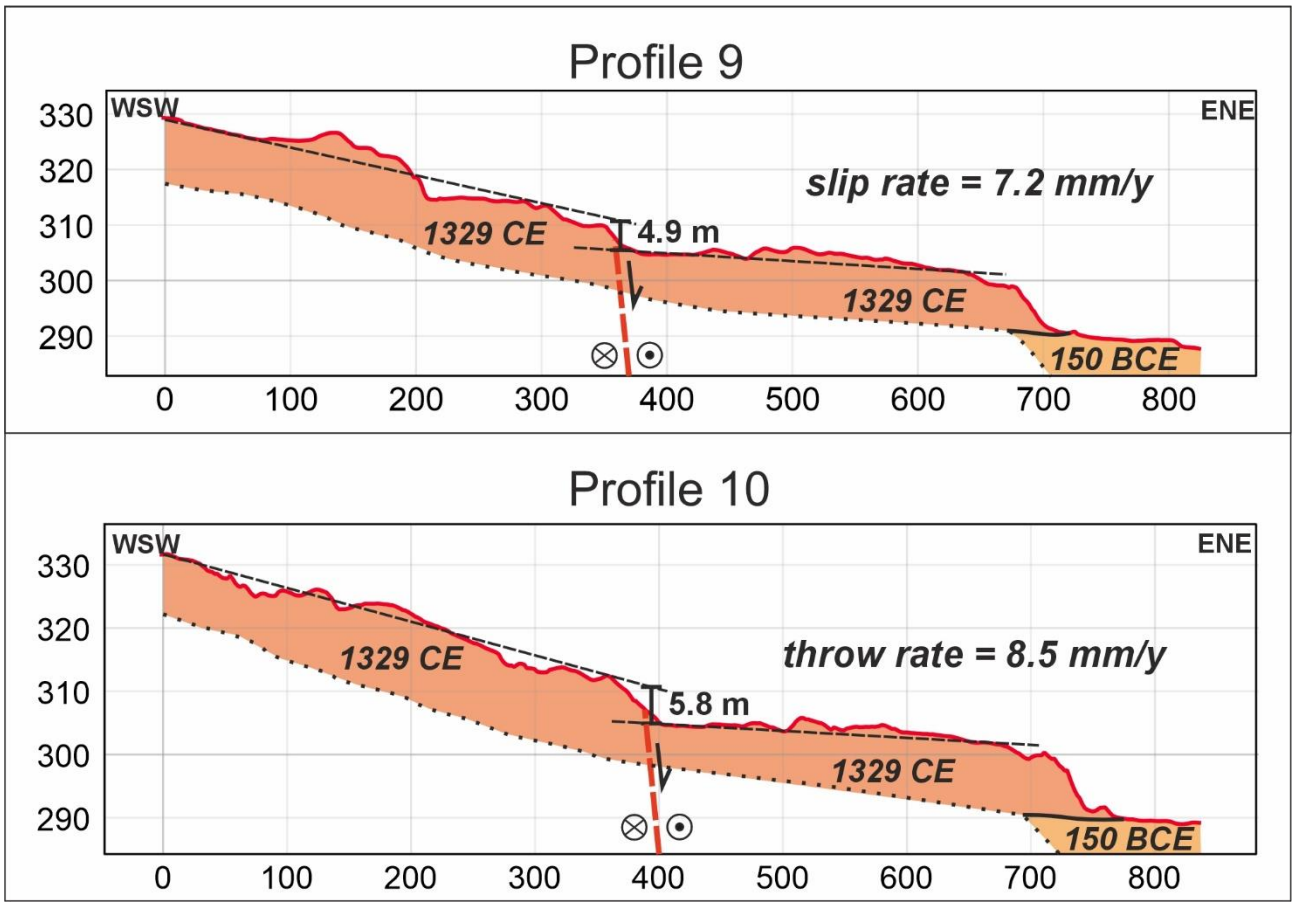

Figure S5: Geological profiles 9-10 along the Fiandaca Fault (FIA).

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