Linking composition and emplacement mechanisms of volcaniclastic mass transport deposits offshore Fogo, Cabo Verde

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1. Introduction and Motivation

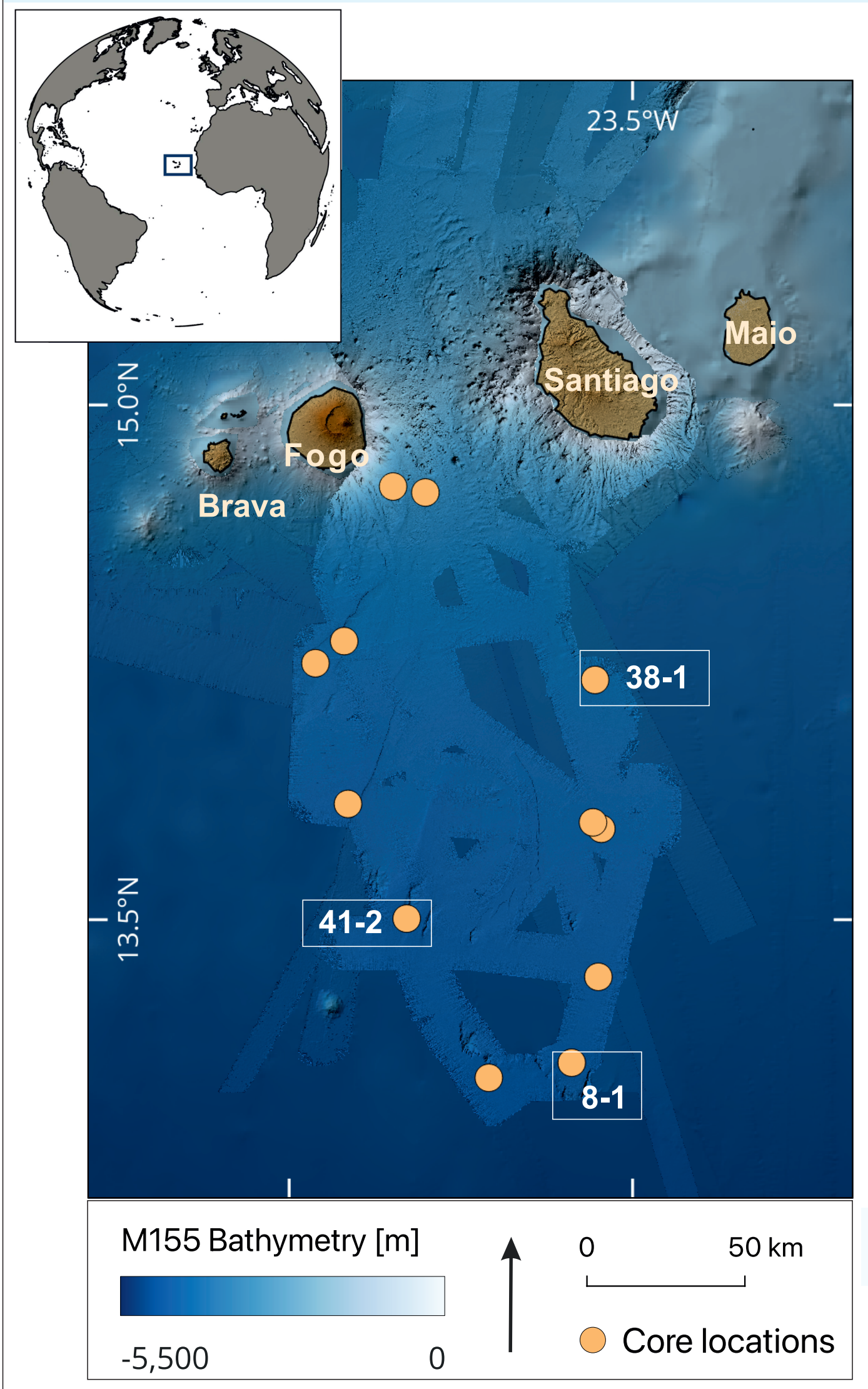

Figure 1: Map of the southern arm of the Cabo Verde Islands showing bathymetry and seafloor features. Cores presented here are highlighted in white.

- Fogo (Cabo Verde) is one of the most active volcanoes in the Atlantic[1].
- The island is shaped by an eastward facing scarp, which is the result of the Monte Amarelo flank collapse (68 ka)[2]. The collapse is interpreted to have triggered a tsunami[3].
- It is the source of several large sector collapses and mass-wasting events, whose debris fields extent far out into the surrounding abyssal plain[4].
- These events pose threats to communities in coastal areas and across ocean basins.
- Marine tephra layers are used as stratigraphic markers as they provide the most complete archives of volcanic eruptions and mass-wasting events[5].

Objectives

- Establish diagnostic criteria for **distinguishing** different types of **volcaniclastic mass-transport deposits** (VMTDs), interpret their **origin** and assign them to **emplacement mechanisms**
- Construct a spatially resolved framework of **depositional patterns** and **flow behaviour** of volcanogenic turbidites south of Fogo

2. Methods and Approach

Sampling
- Marine sediment cores were collected during RV Meteor voyage M155 using a gravity corer.

Sedimentology
- Epoxy peels were prepared to examine sedimentary structures in detail.

Petrology
- Major element oxides: Electron microprobe
- Trace elements: Laser-ICP-MS

Petrography
- Component inventory analysis using smear-slide microscopy

↳ Quantification of mineral-, lithic- and glass-content

Age dating
- Radiocarbon (^{14}C) dating of foraminifera

↳ Calculation of sedimentation rates and age model

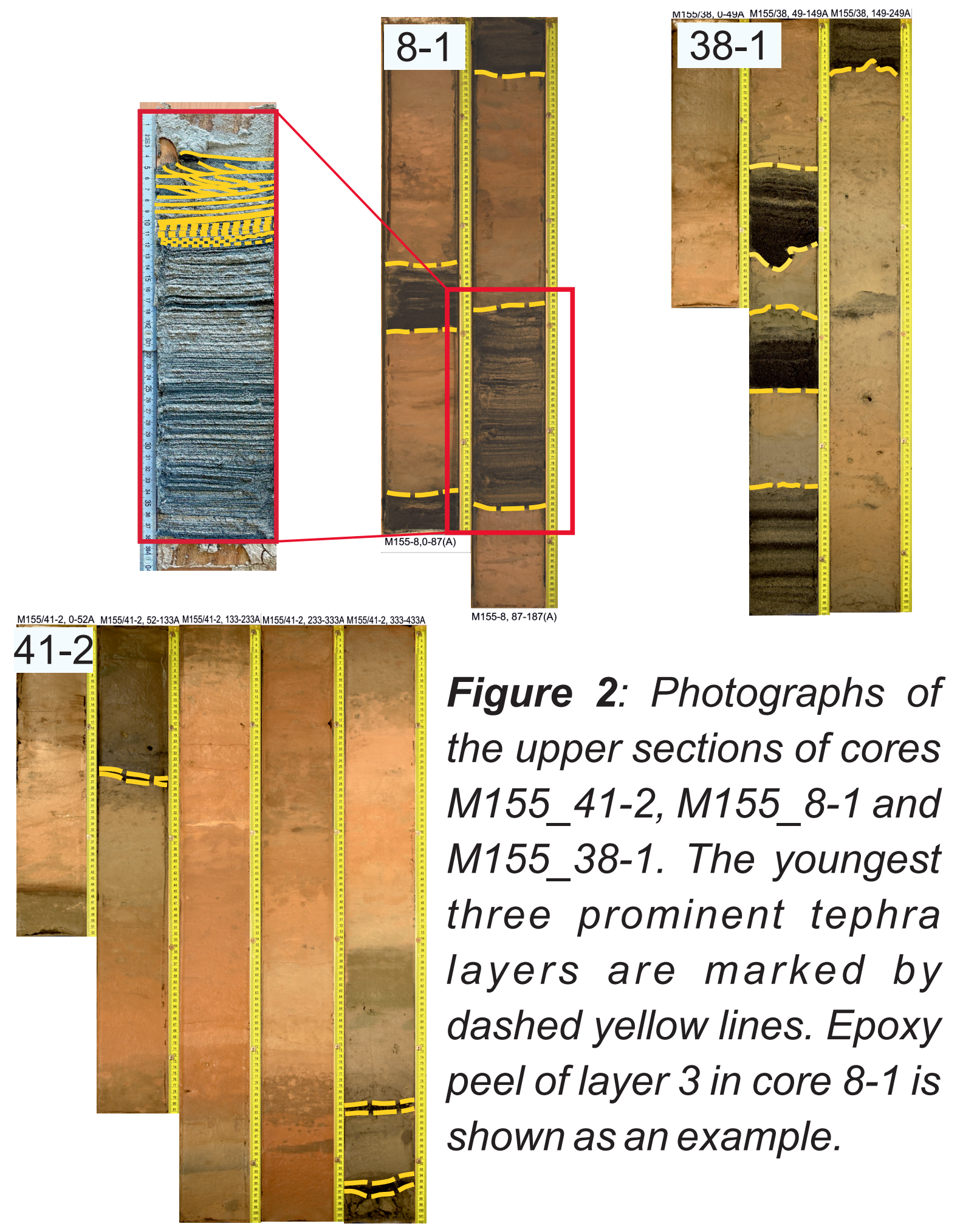

Figure 2: Photographs of the upper sections of cores M155_41-2, M155_8-1 and M155_38-1. The youngest three prominent tephra layers are marked by dashed yellow lines. Epoxy peel of layer 3 in core 8-1 is shown as an example.

3.1 Characterisation of volcaniclastic event layers

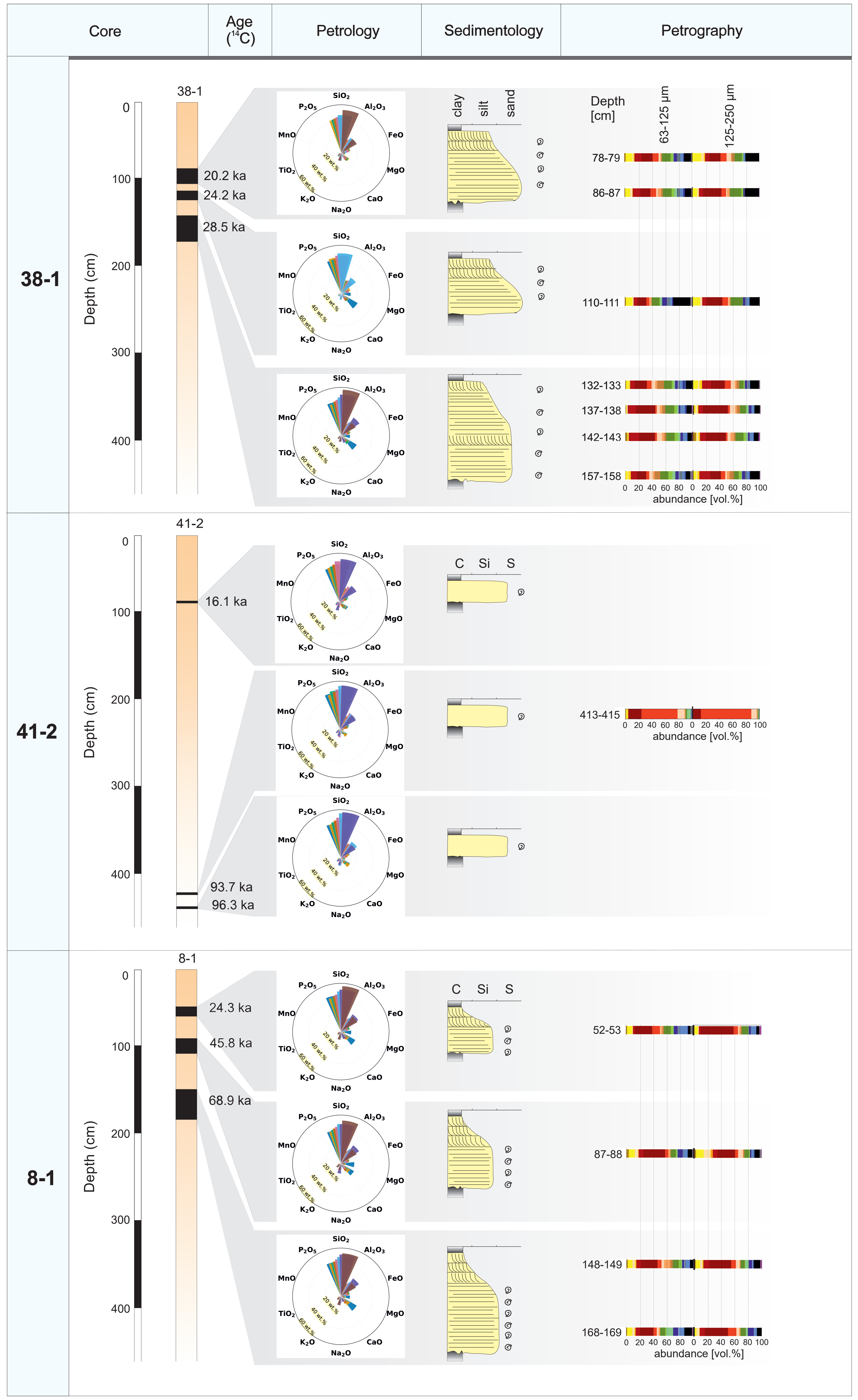

Figure 3: Integrated radiocarbon age, petrological, sedimentological and petrographic data from the youngest three ash layers in marine sediment cores 38-1, 41-2 and 8-1.

Chemical composition
- 🟦 Population 1
- 🟧 Population 2
- 🟩 Population 3
- 🟧 Population 4
- 🟪 Population 5
- 🟦 Population 6
- 🟪 Population 7
- 🟫 Population 8

Sedimentary feature
- Foraminifera
- Scour mark
- Massive
- Cross-laminae
- Planar laminae

Component
- 🟫 Altered glass
- 🟨 Brown glass
- 🟨 Tachylitic glass
- 🟨 Transparent glass
- 🟧 Pumice
- 🟥 Cumulate clast
- 🟥 Volcanic lithic dark
- 🟥 Volcanic lithic with glass
- 🟧 Bioclast (Foraminifera)
- 🟧 Carbonate clast
- 🟫 Sedimentary clast
- 🟩 Augite
- 🟩 Enstatite
- 🟩 Hypersthene
- 🟦 Hornblende
- 🟦 Plagioclase
- ⬛ Potassium feldspar
- 🟦 Olivine
- 🟦 Rutile
- 🟦 Titanite
- ⬜ Fluorite
- 🟩 Zeolite
- 🟦 Zircon
- ⬛ Opaque
- ⬛ Quartz
- 🟪 Nepheline
- 🟪 Sodalith group

- Every tephra layer contains a distinct assemblage of volcanic glass populations, characterised by their major element composition.
- Cores 38-1 and 8-1 host a wide variety in components, whereas 41-2 is defined by >80 vol.% volcaniclastics.

3.2 Provenance

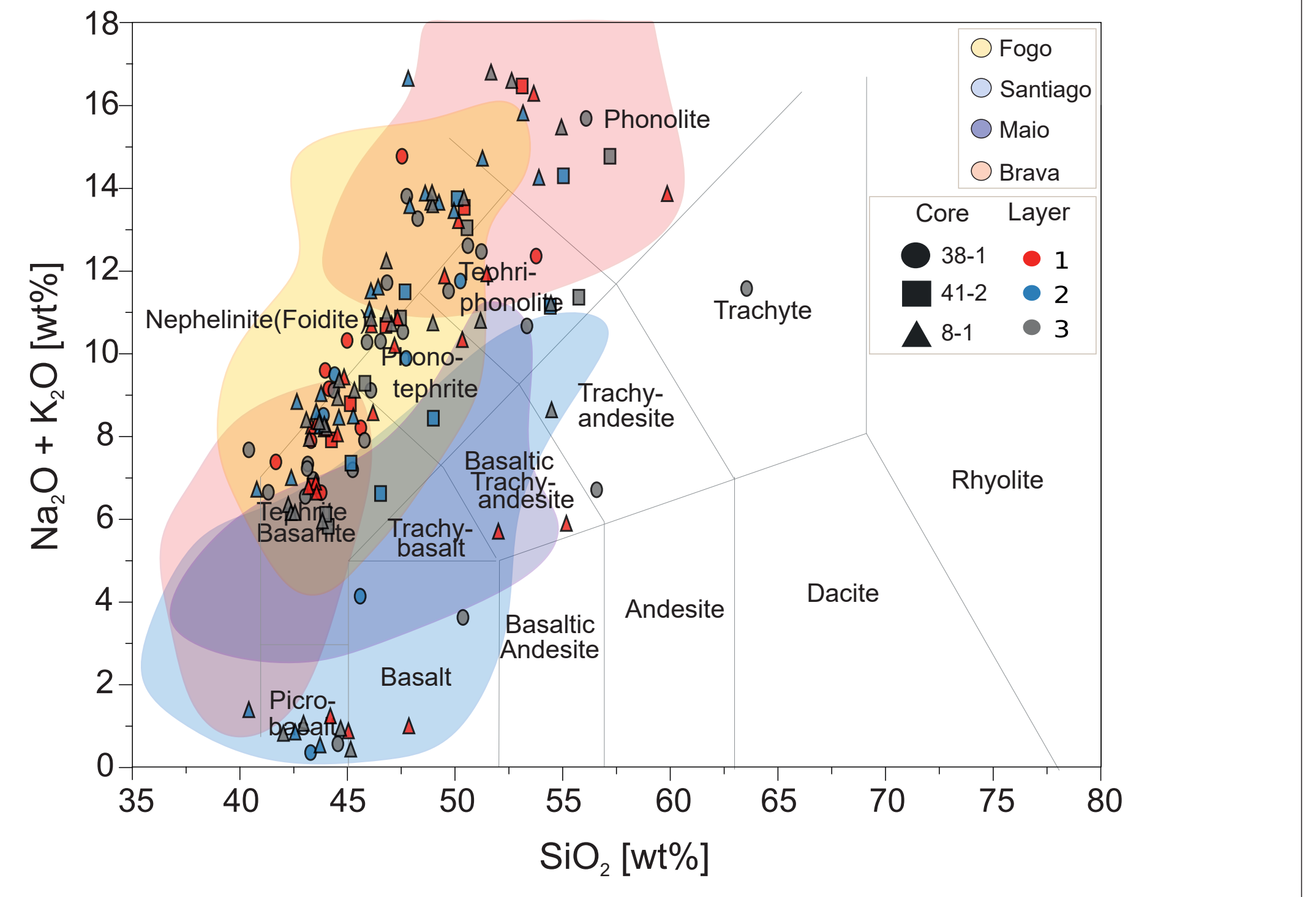

Figure 4: Total alkalis versus silica diagram with compositional fields of the southern island chain[6],[7],[8].

4. Interpretation

Core	Layer	Reworked	Provenance			Bouma	Emplacement
			Fogo	Santiago	Brava		
38-1	1	X	X		X	T_C, T_B	Alternating volcaniclastic and bioclastic laminae indicate episodic reworking of ash deposits and incorporation of biogenic material.
	2	X	X	X		T_C, T_B	
	3	X	X	X	X	T_C, T_B, T_C, T_B	
41-2	1	X	X		X	T_A	Massive layers (>80 vol.% volcanic lithics and glass) with minor foraminifera content indicate volcaniclastic density flow deposition.
	2	X	X	X	X	T_A	
	3	X	X		X	T_A	
8-1	1	X	X	X	X	T_C, T_B	Alternating planar laminae reflect density separation of volcaniclastic and bioclastic components during prolonged, pulsating flow conditions with internal fluctuations in velocity.
	2	X	X	X		T_C, T_B	
	3	X	X	X	X	T_C, T_B	

5. Conclusions and Outlook

- The integrated and detailed characterisation of volcaniclastic event layers is proven as useful for distinguishing deposit types and ultimately infer the materials origin.
- Ongoing work focuses on establishing a continuous composite VMTD chronostratigraphy through correlating marine tephra layers along and across arrays south of Fogo.
- Eventstratigraphy is applied to peform hazard assessment using integrated time-series analysis and probabilistic models of distribution and volume.

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Sharing is encouraged

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Abstract: