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DISTRIBUTION OF ROOTLESS CONES AND LANDFORMS RESULTING FROM WATER-LAVA INTERACTIONS AT HAGI IN THE AÐALDALUR VALLEY (ICELAND)

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DISTRIBUTION OF ROOTLESS CONES AND LANDFORMS RESULTING FROM WATER-LAVA INTERACTIONS AT HAGI IN THE AÐALDALUR VALLEY (ICELAND)

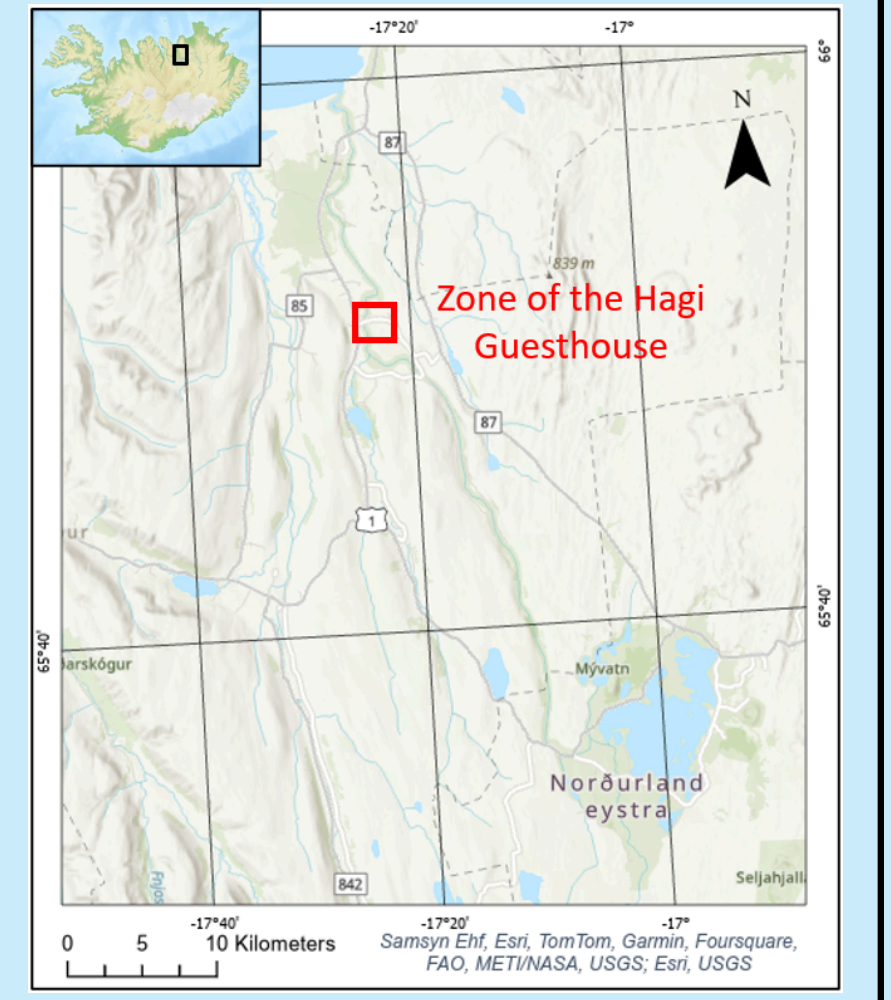
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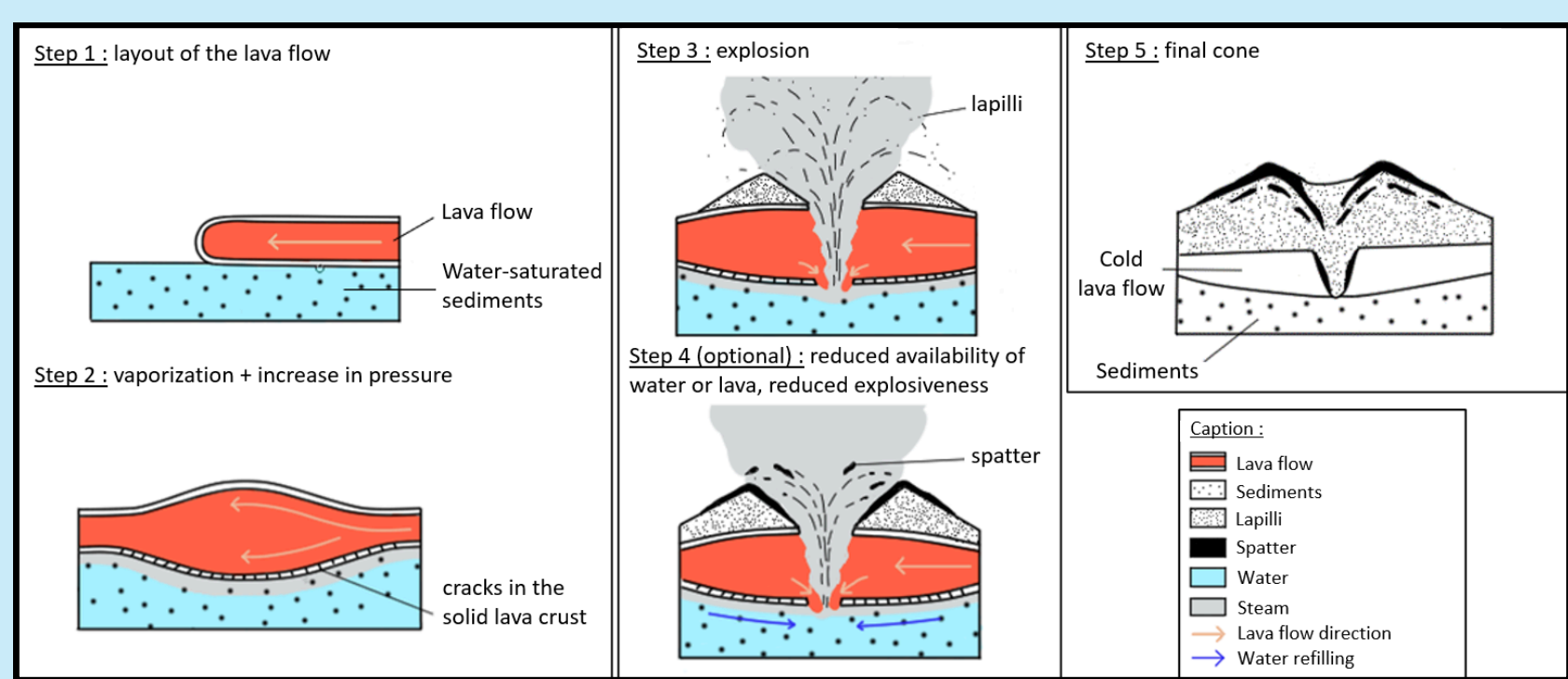
1 Introduction

The region between **Lake Mývatn** and the **Aðaldalur Valley** in **Iceland** is known for its **high concentration of rootless cones**. The **Younger Laxá Lava** that forms these cones is a **basaltic lava** with a **chaotic "aa" surface**, which flowed from the **Þrengslaborgir-Lúdentarborgir eruptive fissure** towards the prehistoric lake of Mývatn, then followed the Laxá valley to Skjálfandi Bay in northern Iceland, covering a **total distance of 63 km** with an **average thickness of ~ 17 m** and a total area of around 220 km² (Höskuldsson et al., 2010). A **classification of crater cone morphology** was proposed for the proximal sector around Lake Mývatn (Noguchi et al., 2016) and then modified by distinguishing hornitos (metric cones of spatter) and applied to the entire valley (Boreham et al., 2018).

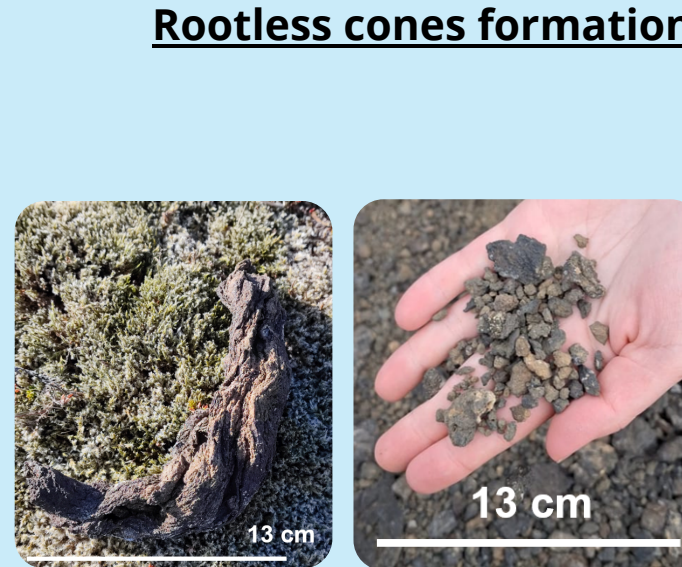
The aim of this study is to **identify the primary and secondary processes** involved in the **formation of volcanic landforms in the Aðaldalur valley** (Iceland) located around 50 km from the eruptive fissure. Primary processes include the **fragmentation of lava by interaction with water**, as well as the **sedimentary transport and deposition** of the **pyroclastic fall** that forms the relief. Secondary processes include **syn- to post-depositional remobilization of tephra**. For this purpose, a 1.1 km² study area rich in volcanic landforms was delineated near the Hagi guesthouse in the Aðaldalur valley.



2 Rootless cones formation

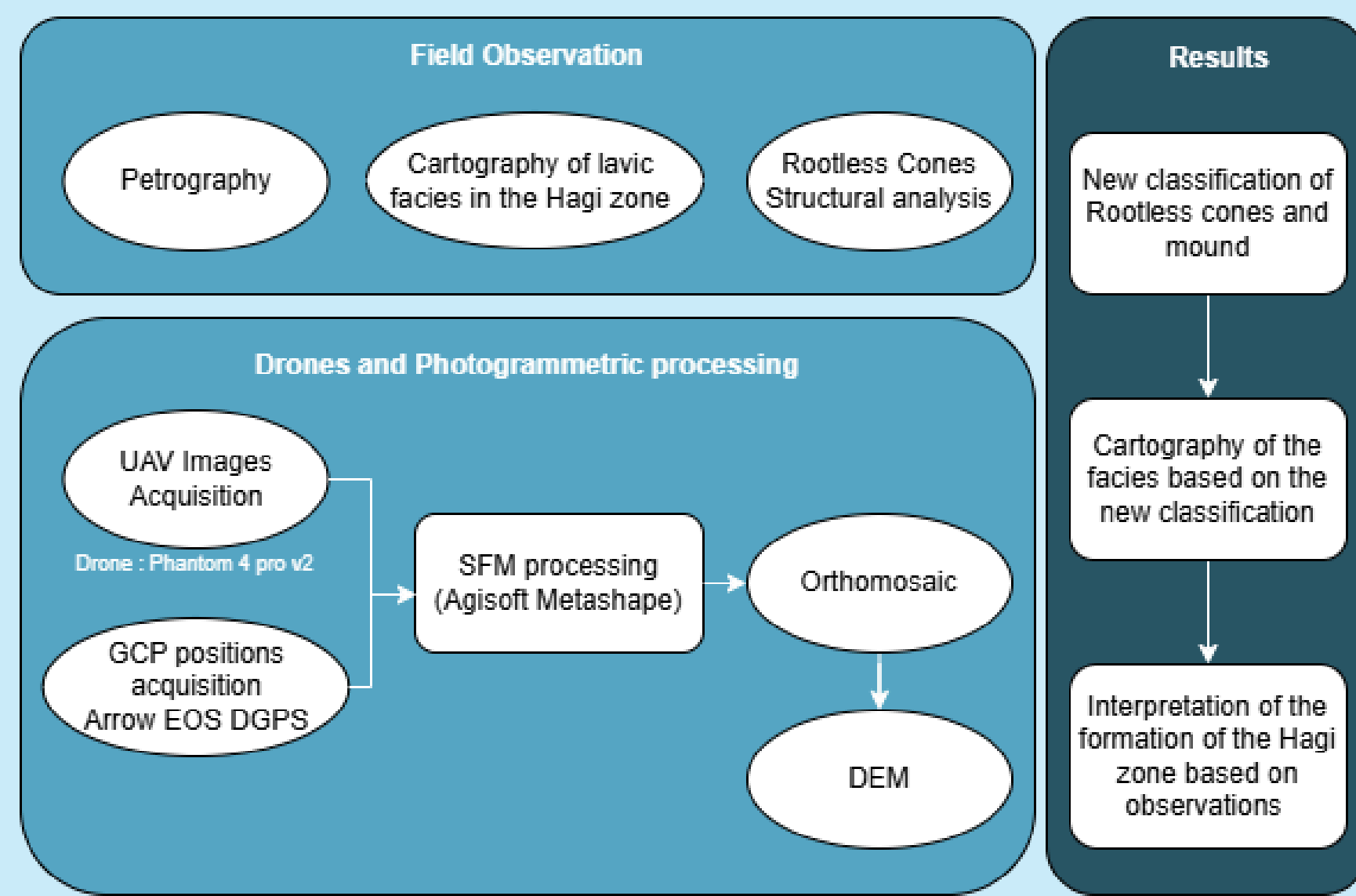


Rootless cones are the result of **local explosions at the surface of a lava flow**, generated when it interacts with a **shallow body of water** (Thorarinsson, 1951) or **water-saturated sediments** (Fagents and Thordarson, 2007). Composed of two main types of volcanic ejecta: **lapilli** (2 to 64 mm), and **spatter** (> 64 mm), soft, plastically deformable bombs, which can aggregate and weld when hot (Boreham et al., 2018).

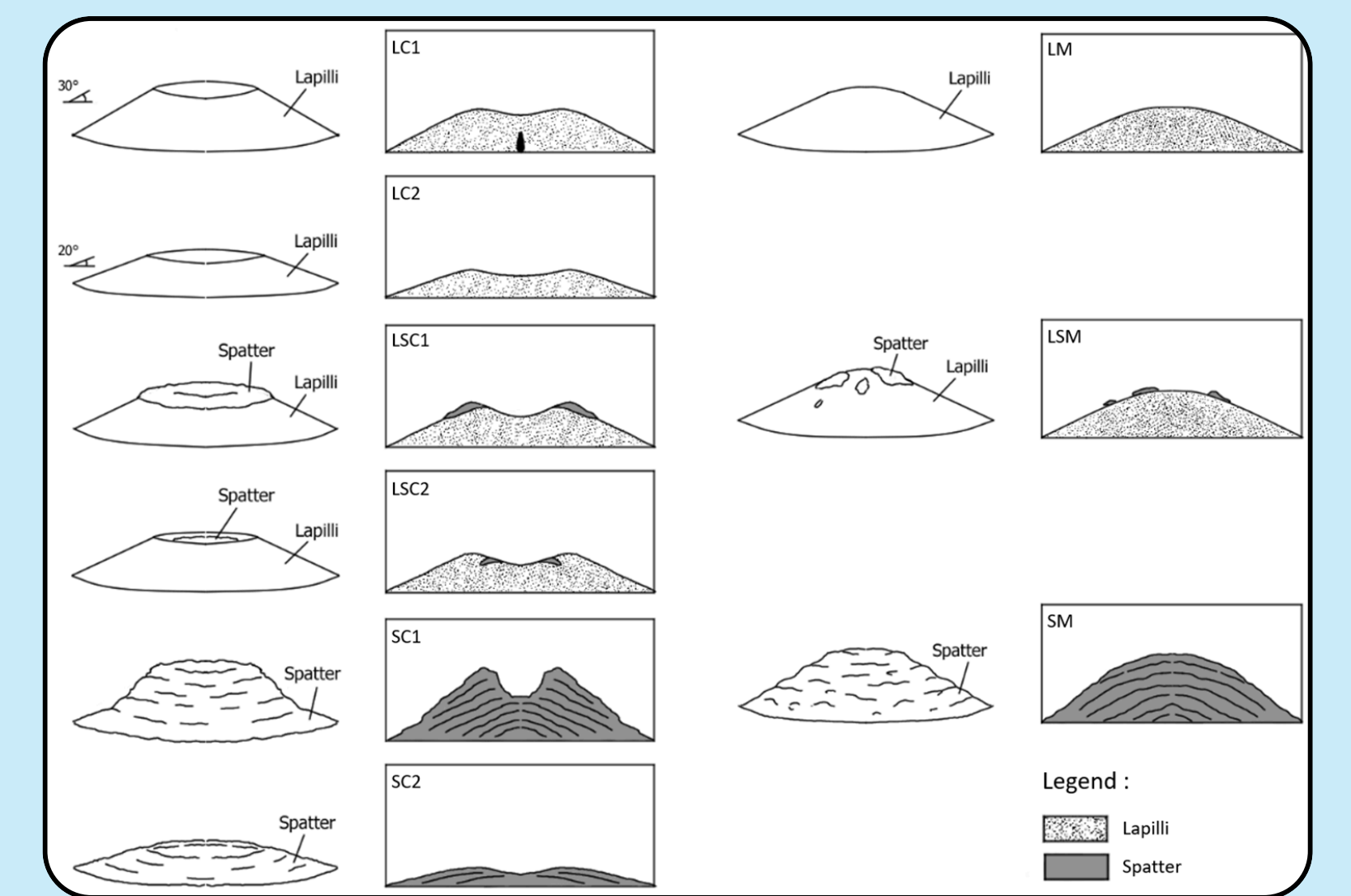


Photography of spatter (left) and lapilli (right) samples.

3 Methodology



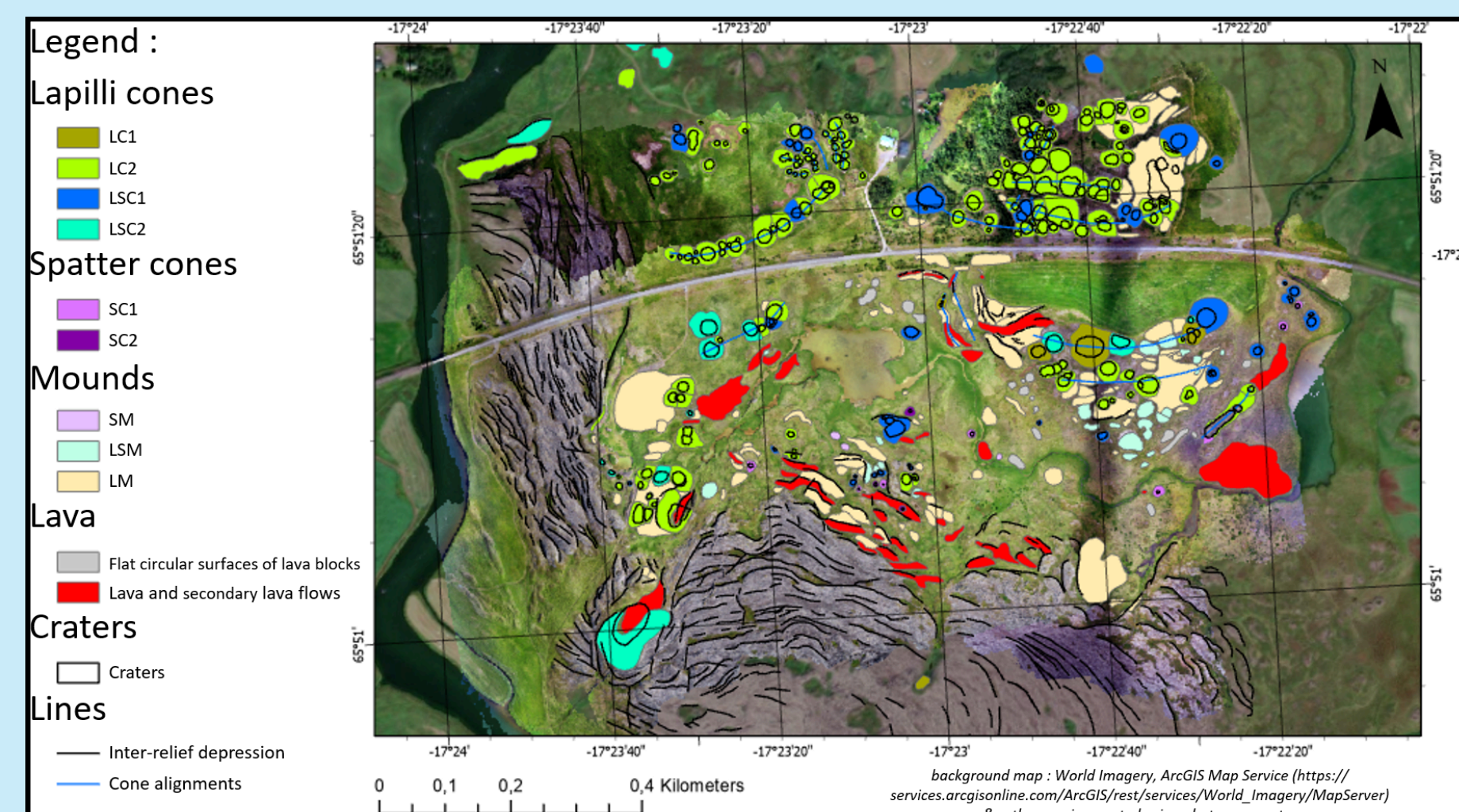
4 Rootless cones classification



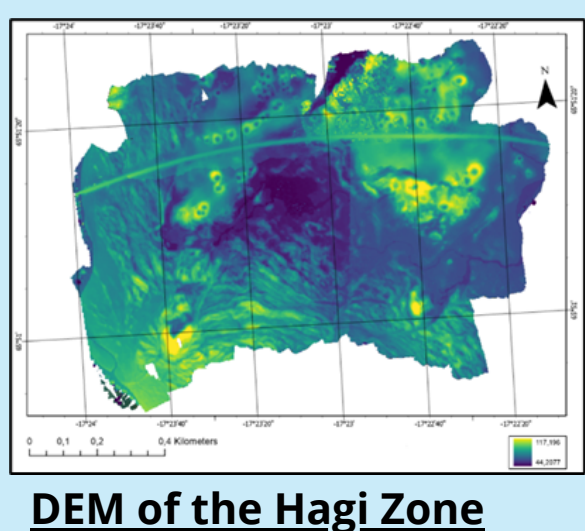
Classification of rootless cones and mounds (modified after (Noguchi et al., 2016))

The classification is based on the **presence of a crater**, the **composition of the cone** (lapilli and/or spatter), the **position** of those components, and their **angle of slope**. The main additions are (i) the creation of a **second type of lapilli and spatter cone**, and (ii) the **definition of mound facies** (LM, LSM, SM) describing craterless volcanic ejecta accumulations.

5 Zone Facies Referencing

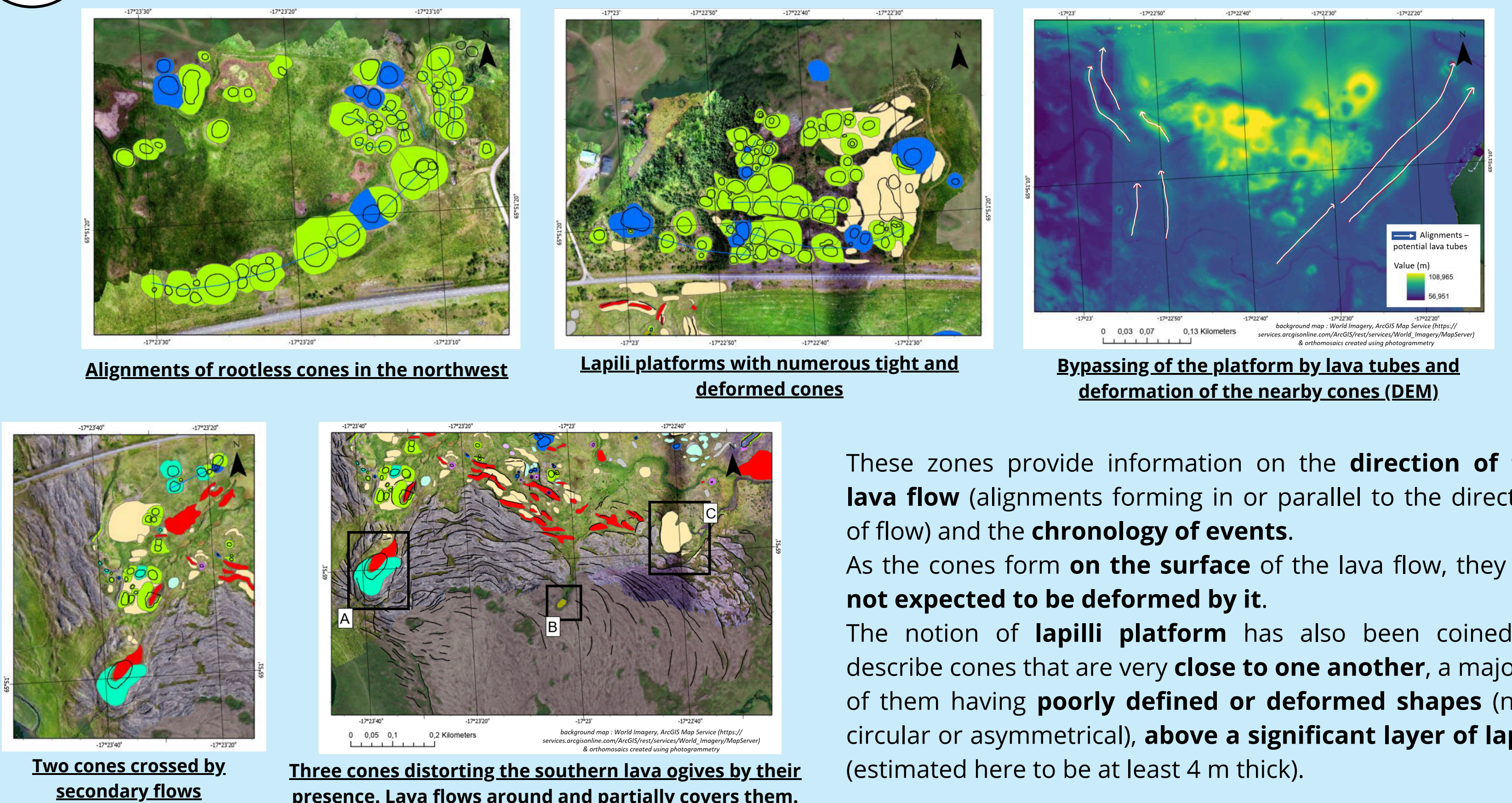


Map referencing the lavic facies in the Hagi Zone



The map referencing facies was created using the information collected **on the field**, such as the **composition of the cones**, their **slope angle** and their **localisation**. Lava facies were also referenced. The **DEM** and the **orthomosaic** were obtained using **photogrammetry**.

6 Areas of interest



Alignments of rootless cones in the northwest

Lapilli platforms with numerous tight and deformed cones

Bypassing of the platform by lava tubes and deformation of the nearby cones (DEM)

Two cones crossed by secondary flows

Three cones distorting the southern lava ogives by their presence. Lava flows around and partially covers them.

These zones provide information on the **direction of the lava flow** (alignments forming in or parallel to the direction of flow) and the **chronology of events**. As the cones form **on the surface** of the lava flow, they are **not expected to be deformed by it**. The notion of **lapilli platform** has also been coined to describe cones that are very **close to one another**, a majority of them having **poorly defined or deformed shapes** (non-circular or asymmetrical), **above a significant layer of lapilli** (estimated here to be at least 4 m thick).

7 Interpretation



Map delineating the two potential flow periods

Two periods can be distinguished in the development of the lava flow.

First phase :

- **Lava's arrival** on the river and wetland, **intense explosive activity**. Creation of a platform of **pyroclastic fall**. Lapilli cones (LC) emerge and tend to **cover their neighbours**.
- **Reduction in the amount of water** during explosions : formation of a spatter layer at the top of some lapilli cones (LSC).

Second phase :

- Continuous flow of lava from the south, it partially **covers the new relief**. It is **diverted on either side** to continue its flow towards the north of the valley. Scoriaceous mounds (LM, LSM) in contact with the flow results from the **deformation of the first cones** and their **mechanical erosion** by the continuous flow of basaltic lava (**disappearance of the craters**).

The tephra relief acts as an **obstacle** that can be **deformed by the flow**. It induces greater deformation of the basaltic flow surface, materialized by the **fragmentation of the solidified crust into blocks** and the formation of **metre-scale pressure ripples**.

8 Discussion

The results provide **new insights into the development of rootless cones** and the **secondary processes** that may have affected them. Other areas in the Aðaldalur valley will have to be studied to complete description and to explain :

- (1) the phenomenon of water-lava interaction
- (2) the origine of transverse alignments of cones
- (3) the detour of lava by a new obstacle.

In addition, the search for **Martian analogues** could enable us to distinguish a scenario of **water or ice source depletion** during the setting up of large basaltic flows.