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Introductory Chapter: Updates in Volcanology - Transdisciplinary Nature of Volcano Science

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1. Introduction

Transdisciplinary approach of science appeared in recent years, partially as a result of the urgent need to deal with global and planetary changes [1–12]. Transdisciplinary science is to answer and solve environmental science questions and problems became the foundation of sustainable development, nature conservation and various environmental science education including geoeducation [13–17]. Transdisciplinary approach within volcanology was always a key element of volcano science as volcanology addresses key questions over volcanic hazards, risk and resilience naturally moving along the interface of social science, humanities, natural science and non-academic (e.g. indigenous) knowledge [18–25]. Especially in recent years more and more researches were conducted on subjects to help to understand the interface between western science and traditional knowledge [26–30]. Such works explored various aspects of volcanism that affected the human societies greatly both as processes that produce natural resources for development and in other hand continuous fear that need to be dealt with to prevent societies from their destructive powers [28, 31–34]. The transdisciplinary aspects of volcanology is reflected well in the new volcano model and volcano geology approach to understand volcanic systems and placing them in a geosystem perspective [35] (**Figure 1**). In many volcano research aimed in recent years to develop some sort of volcano model that explain the volcanic processes, their resulting eruptive products, and the way such models can help to develop a better strategy for resilience against volcanic hazard within a general natural hazard framework [40–43].

2. From volcano geology to volcano model development

The various volcano models distinguish between type of volcanoes commonly categorized monogenetic versus polygenetic volcanoes (and volcanism) as a reflection of the total eruptive volume, the total duration of volcanic activity, the strength of the link to the magma generation source and the stability and longevity of a volcanic conduit [44, 45]. In these models obviously the end-member types of volcanoes define short, small, simple (versus long-lasting, large and complex. Recent decade of research in addition, provided ample evidences that the scale of observation (hence the detail of information could be mined from volcanic systems) is important, and provides evidences to support that in real world end member type of monogenetic volcanoes are rare, and most of them shows some sort of complexity in a near continuous spectrum [20, 46–52]. This is more apparent when the magma that form those volcanic geoforms are more evolved [53, 54]. In recent years attention

Figure 1.

Complex volcanic landscape in northern Chile is a fine example to demonstrate the volcano geology approach to interpret the present day geoforms. The landscape is ruled by the basaltic-andesite to dacite lava dome-dominated Ollagüe (5868 m asl) stratovolcano, which stands 1686 meters above the surrounding Salar de Carcote desert floor. The volcano has an active hydrothermal system in its top (note the white cloud in the right edge of the summit), while the volcano itself had its last eruption about 65 ka [36, 37]. In the side of the volcanic edifice satellite domes formed such as the El Ingenio lava dome in the NW (left in the image) side of the cone [38]. In the foreground a typical hummocky surface of volcanic debris avalanche that generated by a sector collapse can be seen that formed in the late-Pleistocene. The image was taken from a small scoria cone La Poruñita, that is part of a monogenetic volcanic field nearby and formed after the sector collapse of the stratovolcano [39]. This complex geological setting of this volcanic system highlights the importance to study volcanoes from volcano geology perspective.

also turned toward effusive style of volcanism that is not obviously can fit into any of these categories. The current eruption of Iceland's Reykjanes Peninsula that started on the 19th March 2021 8.45 PM (Local Time) provided an exceptional occasion to observe how a volcano starts its life (**Figure 2A and B**). Commonly, the first moments of a volcano's growth are missed by direct observation and later on the initial eruptive products become covered by subsequent eruptive products, missing key elements of the early, very critical phase of the eruption [55]. The new eruption in Iceland, that gradually builds the new volcano Geldingadalir operating along an approximately 800-meter long fissure and at least 6 distinct vent zones (**Figure 2A and B**). The opportunity to observe the vent localization process commonly based on a combination of direct observation and study older volcanic successions [56, 57] is valuable to understand fissure-fed eruptions. Such geological observations and records can provide a dynamic view on fissure-fed eruptions in basaltic systems and help to interpret the resulting eruptive products (**Figure 2C and D**). In this respect the interlink between observation-based volcanology can be linked to various geoeducation works that provide good, evidence-based information to understand the volcanic geoheritage [58]. In case of the growth of the Geldingadalir volcano, it provides insight on the formation of steep spatter cones documented from the geological records elsewhere, for instance during the 1256 Al Madinah eruption in Saudi Arabia [59].

Numerous research work has been completed with a prospect to provide volcanic hazard maps [60–65] as well as some sort of tools to communicate to communities volcanic hazards [66], co-design, co-product programs and products to help developing a more resilience community that can live with the volcanoes and their hazards [28, 67–78]. In recent years, there is also a strong movement visible

Figure 2. Lessons from the current volcanic eruption of the Geldingadalir volcano in Iceland can be used to better understand of the first moments and processes of a volcano growth in basaltic systems (A, B). Flow localization formed vents that emitted lava and spatter creating steep spatter cones (A) through mild explosive event (B). To see this process in real can help to interpret similar volcanic successions elsewhere such as those formed during the 1256 Al Madinah eruption in Saudi Arabia (C) or during the Pleistocene and Holocene in the Harrat Khaybar, also in Saudi Arabia (D). The solidified inner structure of a spatter cone shows well the steep pile of spatters accumulated around the vent (D) similar how such process take place right now in Iceland (B). Photos of A and B are from the photo collection of Viktória Komjáti.

to conduct research jointly with other experts in archaeology for instance to better understand the impact of volcanism on early civilizations [79–93].

3. Volcanic geoheritage

Moreover in the last decades a boom of research is visible where volcanic geo-heritage used and utilized as a main opportunity to develop geoeducation programs accompanied with effective geoconservation programs (commonly formed as a result of citizen science, and co-design) to build a more resilience society against volcanic hazard [94–104]. Even new terms appeared such as social volcanology or paleo-social volcanology steamed from social geology to express the newly and rapidly evolving discipline formed recently [72, 105]. Most of this works based on a more precise and process-oriented understanding of volcanic systems such as monogenetic volcanoes. The dynamic progression on volcanic geoheritage, geodiversity and geotourism research made a new aspect of volcano science where interface between natural sciences, humanities and social sciences meet and put into practical sense making volcanology a more relevant science to human society and our natural environment

Figure 4.
Location keywords identified on Web of Science Core Database in the papers published since 2019 in the two major volcanology scientific magazines, Bulletin of Volcanology (A) and Journal of Volcanology and Geothermal Research (B).

Figure 5.
Word map derived from the title and abstracts of the last 12 months papers published in BV and JVGR based on Web of Science core database.

Puna, Andes and Etna as top for BV (Figure 4A), while **Andes, StHelens, Etna, and Iceland** having the most common location keywords for JVGR (Figure 4B).

The following method was applied for a narrower time frame (**last 12 months**) but looking at the **title, keywords and abstract** of the published papers in the two major volcanology magazines (Figure 5). From the 101 published papers the **Erupt, Volcan, Volcano, Lava, Magma** words were the most commonly used while in the “second” abundance more process-related words such as **Flow, Deposit, Data, Model, Explosion, System, Observe** etc. appeared.

As volcanic geoheritage became an important aspect of volcano science recently we checked the main keywords associated with researches identified under volcanic geoheritage topic search term from the Web of Sciences Core Databases. A total of

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