Preparation and Resistance to Eruption of IberoAmerican Volcanes (PREVIA): an interdisciplinary study of Apoyeque, Nicaragua

‘The biggest eruptions tend to occur at volcanoes we know nothing about’ (1).

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Rationale

The project is interdisciplinary in nature, combining innovative techniques from both the natural sciences and the social sciences to address the problem: how could society become more resilient to the risks and natural hazards associated with volcanoes. It focuses on volcanoes that have not erupted in recent times, are considered dormant, but have had powerful historical eruptions and are also located near large urban centers, therefore they are particularly dangerous.

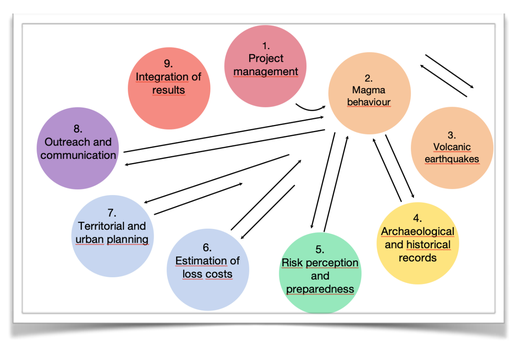

Fig. 1
Interdisciplinary links

1. Field work

In May 2022 a team of 5 University of Granada (UGR) researchers undertook a field campaign in Nicaragua focusing on the Apoyeque volcano, located 9 km northwest of Managua, (pop. >1,000,000).
Work was undertaken in collaboration with colleagues from the Nicaraguan Territorial Studies Institute (INETER), the National Autonomous University of Nicaragua (UNAN) and the Centre of Geophysical Research (CIGEO).

2. Psychology

- Design and collection of online surveys (N=500) exploring perceptions, attitudes and sense of preparedness in the case of an Apoyeque volcanic eruption scenario.
- One workshop with school teachers focusing on psychosocial perspective of disasters, providing techniques for stress management and community preparedness.
- Two workshops with psychology and medicine students regarding psychological first aid and emergency response.
- Development of an online stress management training course for INETER emergency response staff.

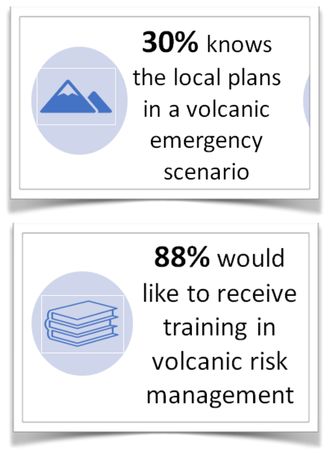

Fig. 2
Online survey screen grab and results

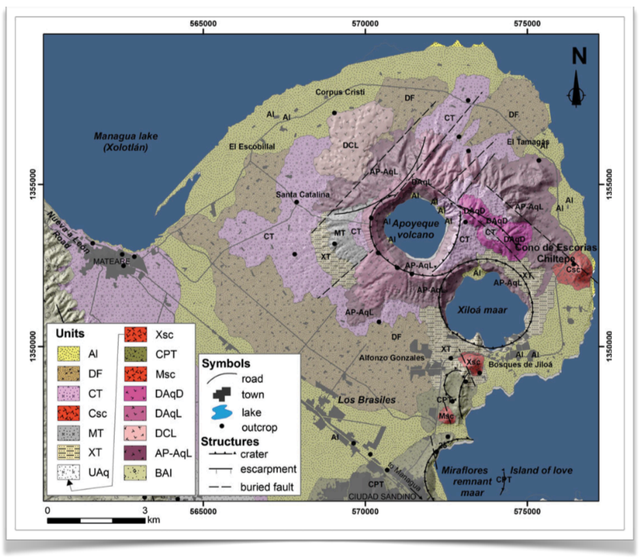

Fig. 3
Geological map of Apoyeque volcano, Chiltepe peninsula (3)

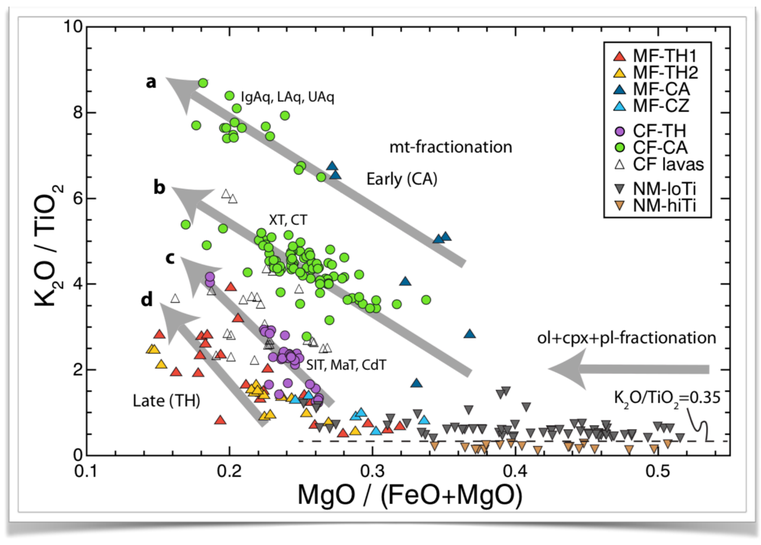

Fig. 4
Apoyeque volcanic units stratigraphy and major element trends (4, 5)

3. Geology

The last known eruption was a Plinian paroxysm 2,000 years ago (2). It is relevant because in eruptions of this type, so explosive, tephra. 15 tephra samples were collected, the analysis of which is the focus of the current application. Stratigraphy currently dated by ^{14}C.

Planned analyses include:
- Whole-rock major and trace elements.
- Mineral chemistry.
- U-Th zircon and apatite dating.

We need to have the most complete record of the geological history of a volcanic center to contemplate future scenarios.

4. Geophysics

- Workshops on neural networks, artificial intelligence and machine learning with monitoring and seismology staff from the Nicaraguan Territorial Studies Institute (INETER) and the American University, Managua.
- Joint work to analyses configure, maintain and recover Differential Optical Absorption Spectroscopy ‘DOAS’ gas equipment from INETER stations.
- Meetings to establish cooperation processing INETER infrasound data.
- Installation of a link to the UGR server for upload of seismic data.

Fig. 5
Earthquake early warning systems.

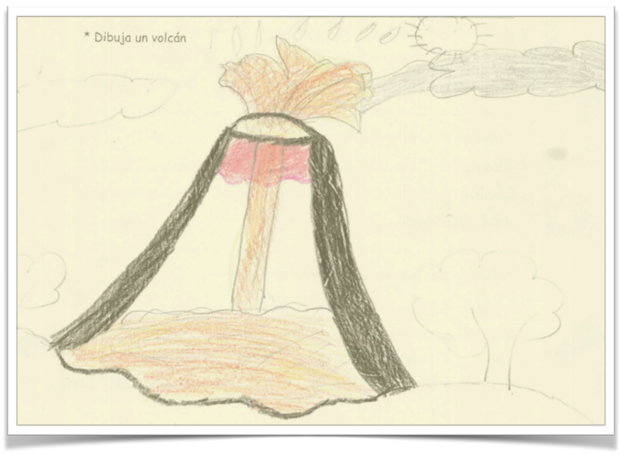

Fig. 6
Child´s drawing of a volcano…

5. Education

- Three schools visited in the Managua area - workshops on volcanic processes.
- Questionnaire given to pupils, including: “draw a volcano”.
- 162 pupils participated: 100 7-9 years, 162 between 10-15 years.
- Analysis of drawings and categorization of volcano shape:
  - Most drew an acute-elongated isosceles.
  - This contrasts with the obtuse-elongated isosceles shape of the stratovolcanoes in their region.
  - Similar results were obtained in other areas such as Catania (Italy) or Tenerife (Canary Islands, Spain) (6).
- The implication is:
  - Children’s mental models are less influenced by their surroundings than information from television and other mediums.

6. Urban planning and legislation

- The Managua Master Plan project considers earthquakes, floods and landslides as the main natural hazards in Managua.
- General structural measures have been instigated to mitigate these, e.g., retaining walls.
- Non-structural measures include land use regulation for high risk areas, e.g., classification of land as rural to protect steep slopes and ground from water erosion.
- No references are made in the Master Plan to volcanic eruptions as natural hazards.

- Further non-structural measures such as updating risk maps and development/updating prevention and early warning systems could be useful (and cheap) for mitigating an Apoyeque eruption.

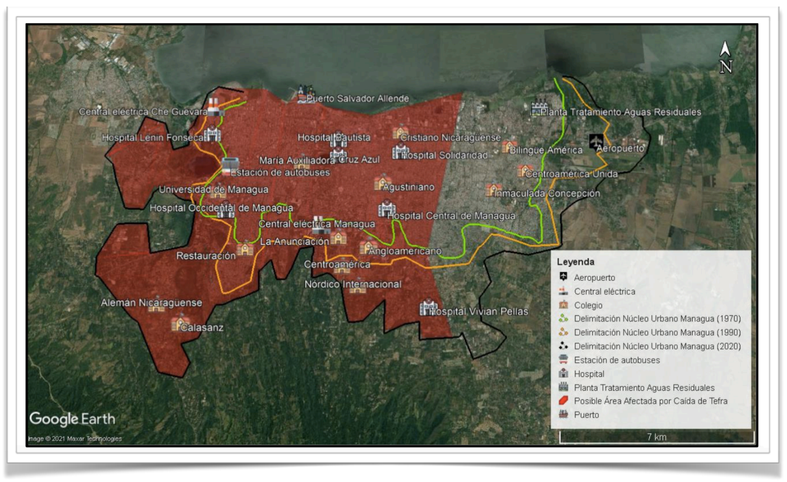

Fig. 7
Google Earth images showing key infrastructure in Managua city and growth towards Apoyeque volcano over the last 40 years (7)

7. Economy

- Estimation of damages and potential losses, in the event of an eruption of Apoyeque
- Design of the most appropriate methodology for the estimation, based on the social and economic characteristics of the analyzed area.

Achievement these objectives depends on obtaining information from Nicaraguan institutes.

Meetings with INETER and CIGEO colleagues regarding territorial planning area, including:
- Characteristics of the area analyzed.
- Exploring alternatives for obtaining official information.

References: 1. Oppenheimer C. 2011. Eruptions that shook the world. Cambridge University Press; 2. https://volcano.si.edu/; 3. Avellán et al 2014, doi: 10.1007/s00445-013-0792-4; 4. Kutterolf et al 2007, doi:10.1016/j.jvolgeores.2007.02.006; 5. Freundt and Kutterolf 2014, doi: 0.1007/s00445-019-1321-x; 6. García-Yeguas et al 2022, Talk, 30 Encuentro de la Didáctica de las Ciencias Experimentales; 7. Pérez Vigo 2021, Undergrad. diss., University of Granada, Spain.

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