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3. Best Practice/Ideas in the Geography Class/Lesson Plans/Fieldwork/Teaching Strategies/Contentious Issues in Geography

3.1 Proposal to extend the Grade 10 Geography curriculum for teaching the topic volcanoes and earthquakes

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Abstract
An extension of the Grade 10 curriculum for teaching the topic of volcanoes and earthquakes in intraplate\(^1\) areas is proposed in this article. The extension could include hotspots\(^4\) and mantle plumes\(^3\) underneath the interior of a plate that may cause volcanoes and earthquakes outside the plate boundaries. This occurs when hot mantle material bores from the plume through the crust to a hotspot at the surface where it erupts at a volcano. Even though intraplate volcanoes and earthquakes are very rare they occur with the same devastation and are as deadly as those at plate boundaries. Examples of active intraplate volcanoes are Kilauea in Hawaii as well as Nyiragongo and nearby Nyamuragira in the Democratic Republic of the Congo. Kilimanjaro is an example of a dormant volcano in East Africa. This extension would teach Grade 10 learners in Southern Africa more about the physical geography of their continent.

**Keywords:** Volcano; Earthquake; Grade 10; Curriculum; Intraplate

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\(^{1}\) Defined in glossary of terms at the end of the article.
Introduction

When we receive visitors from schools at the South African National Seismograph Network, Council for Geoscience, Pretoria, I always ask them about the seismicity of South Africa and volcanoes on the African continent. Most of the learners are aware of the magnitude 6.3 Ceres-Tulbagh earthquake of 29 September 1969 (Brandt et al., 2019) but almost no one has any knowledge of volcanoes or earthquakes that occur in Africa. In response an explanation of how hot mantle material underneath Eastern Africa could bore through the crust and exit the surface at a volcano or cause earthquakes is usually well received by the learners (“Hotspots: Mantle thermal plumes”, 1999).

The lack of knowledge learners have of African volcanoes/earthquakes could be because the current Grade 10 curriculum teaches the topics plate tectonics, volcanoes and earthquakes with emphasis on plate boundaries (“Shutters top class Geography Grade 10 teacher's resource book”, 2018; “Grade 10 Geography — Via Afrika”, 2018). This is in line with the traditional curriculum developed during the 1970s and 1980s (Hamblin, 1985; Press & Siever, 1986). However, as I will show below, new knowledge of intraplate volcanoes and earthquakes gained since the 1990s could mean this approach may no longer be best practice to teach Grade 10 learners. The current curriculum also does not emphasise teaching Southern African learners about their continent.

Current curriculum

The current curriculum for plate tectonics includes a description of continental drift; evidence supporting the movement of continents over time; the major plates of the world; and definitions for constructive, destructive, conservative and colliding plate margins. Earthquake formation; earthquake measurement and recording; earthquake waves; earthquake strength; earthquake effect; and earthquake preparedness together with tsunamis make up the curriculum for earthquakes. The curriculum for volcanoes includes volcano formation; volcano classification; volcano types; and volcano impact (“Shutters top class Geography Grade 10 teacher's resource book”, 2018; “Grade 10 Geography — Via Afrika”, 2018). Earthquakes and volcanoes are linked to plate boundaries.

2 The article is not meant to criticize this study guide nor does this article suggest in any way that this guide might be inadequate or incomplete.
Grade 10 Geography — Via Afrika study guide (2018, p. 54), for example, emphasises the following next to two maps of earthquakes and volcanoes around the world:

“Note that belt of earthquakes occurs where plates are moving apart — North and South American plates on the left and African plate on the right. A belt of volcanoes is also evident in this region”.

No mention is made of intraplate earthquakes and volcanoes inside plates. Shuters top class Geography Grade 10 teacher's resource book (2018) does look at the East African Rift valley but does not explain the theory behind the intraplate earthquakes and volcanoes. This is in line with the authoritative physical geography textbook “The Earth's dynamic systems” (Hamblin, 1985, p. 376) which states that:

“Volcanic eruptions in the central parts of plates beyond the active margins, are trivial compared with those along spreading centres and subduction zones, but may be important as surface expressions of local thermal variations, or hot spots, in the mantle material”.

I am of the opinion that this approach of teaching Grade 10 Geography in the present day no longer follows best practice for three reasons:

• Kilauea volcano in Hawaii began erupting on 3 May 2018 and was accompanied by a magnitude 6.9 earthquake (Hanna et al., 2018). Closer to home, in the Democratic Republic of the Congo, Nyamuragira erupted in 2010 (“Volcano erupts in Congo”, 2010) and Nyiragongo in 2016 (“Nyiragongo volcano (DR Congo)”, 2016). These three intraplate volcanoes had been active for many years before the latest eruptions;

• Seismic wave tomography has imaged plumes in the mantle below plate boundaries, e.g. Iceland, and in the interior of plates, e.g. East Africa (Ritsema et al., 1999). We now understand plumes better than in the 1970s and 1980s when they were considered to be a mysterious theory and their relationship with plate tectonics was not well understood; and

• The current curriculum does not allow Southern African Grade 10 learners to acquire more knowledge about the plume under East Africa that causes most of the volcanic/seismic activity in this interesting area of the African continent in the East African Rift.
Proposal for extension
In addition to the current curriculum the following concepts are proposed to extend the Grade 10 curriculum to include the topic of intraplate volcanoes and earthquakes:

- A very small number of volcanoes occur in the interior of plates. These volcanoes, however, can be as devastating and as deadly than volcanoes that occur on plate boundaries;
- Volcanoes and many earthquakes in the interior of plates are caused by underlying mantle plumes. A plume is a relatively small, long-lasting and exceptionally hot region in the mantle. A hotspot is a volcanic region (at the surface) fed by an underlying mantle plume;
- Plumes and hotspots can also occur at plate boundaries, e.g. Iceland;
- In the intraplate hot mantle material may bore from the plume through the lithospheric mantle and crust to a hotspot at the surface where it could erupt at a volcano;

![Figure 1. Schematic representation of an intraplate volcano above a magma plume.](image)
• Relevant examples are Kilauea volcano in Hawaii, an active shield volcano above a plume within the Pacific oceanic plate, and Kilimanjaro, a dormant volcano in East Africa, on a continental plate;
• The plume under Hawaii is stationary in the mantle, it is the Pacific plate that moves over the plume; and
• East Africa is situated above a plume which is the cause of most earthquakes in that area. This provides an explanation for the seismicity in the interior of the African plate and volcanoes associated with the East African Rift. (Refer to figure 1.)

Glossary of terms
Mantle plume, also referred to as a plume, is a relatively small, long-lasting and exceptionally hot region in the mantle.
Hotspot is a volcanic region (at the surface) fed by an underlying mantle plume.
Intraplate earthquake refers to an earthquake that occurs within the interior of a tectonic plate. This stands in contrast to an interplate earthquake, which occurs at the boundary of a tectonic plate.
Seismic wave tomography is an imaging technique that uses seismic waves generated by earthquakes or explosions to create images of Earth’s interior. It is similar to a medical Computerized Axial Tomography (CAT) scan that produce images of the interior of a human body by means of X-rays.
Seismicity is a measure which encompasses earthquake occurrences (how often earthquakes take place) and magnitudes (an estimate of the size or strength of an earthquake) at a given geographical location or region. It summarizes a region's seismic activity.

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References


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