Evidence for a Two-Stage Eruption at Trimble Knob, an Eocene Volcanic Plug in Highland County, VA

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Abstract

Trimble Knob is a hill formed by a basaltic Eocene neck located in Highland County, VA. It is one of a plethora of Eocene igneous bodies in the Valley and Ridge Province erupted between 48-35 Ma (Southworth 1993). The neck is 30 m in diameter and is located near the hinge of a SW-trending syncline along the contact between the Devonian Millboro Shale to the east and the Devonian Ridgeley Sandstone to the west. In this study, detailed field observations of the contact zone of the igneous body as well as petrographic observations are used to test two hypotheses: 1) Trimble Knob formed during a single eruption; 2) multiple eruptions occurred at Trimble Knob.

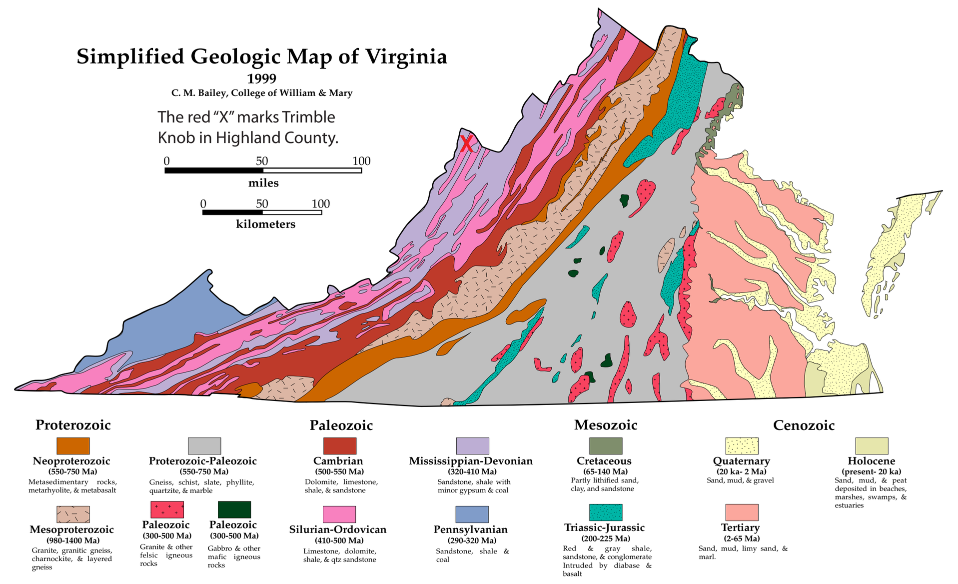
At the peak and on the western side of the exposed neck, poor- to moderately-developed columnar jointing is present. The basalt contains clinopyroxene and olivine phenocrysts in a fine-grained groundmass. The columnar basalt transitions to massive basalt along the southeast edge of the hilltop. A debris flow scarp has exposed the bedrock on the eastern slope of Trimble Knob. A transition zone of basalt with a hackly texture extends about 12 m down the eastern side of the neck and includes sparse angular black shale xenoliths several cm across. In thin sections, autolithic basalt fragments are cemented with carbonate minerals. Below the transition zone, a diatreme breccia containing rounded to subrounded xenoliths of shale, tan sandstone, and gray limestone is observed. In thin section, carbonate cement, clinopyroxene and olivine phenocrysts, and autobrecciated basalt clasts are observed. Based on field observations and petrographic characteristics, the diatreme xenoliths are identified as the Milboro Shale, the Ridgely Sandstone, and limestone from the Helderberg Group. The diatreme breccia was created by an explosive eruption that ripped out clasts of the country rock in a chaotic fashion. We propose that there was a two-stage eruption at Trimble Knob. An initial explosive eruption produced the diatreme, followed by a less violent flow of magma through the center of the plug.

Background

•Trimble Knob is an Eocene Volcano located in Highland County, Virginia, which erupted 48.86±.37 million years ago (Bulas 2012).

•The basaltic neck cuts through two rock units; the Devonian Millboro Shale and the Devonian Ridgeley Sandstone.

•The mechanism for eruptions of Eocene volcanics in Virginia is still in question and a comprehensive understanding of the dynamics of the Trimble Knob eruption provides context for a tectonic hypothesis (Southworth 1993).



Methods

•Detailed field mapping; included taking pictures, gathering rock samples and marking GPS coordinates of significant features.

•Prepared thin sections for petrographic analysis.

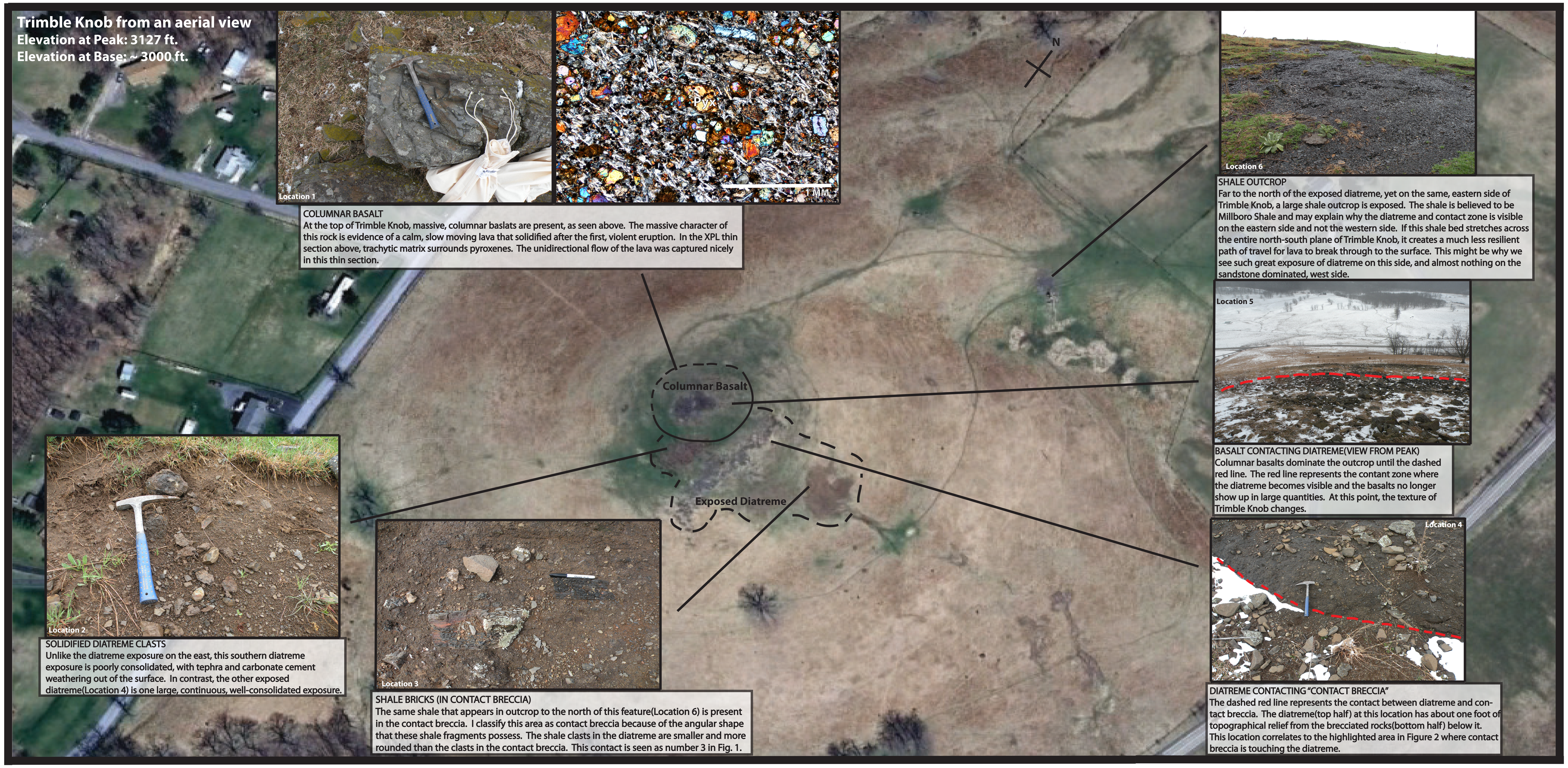
•Several samples were sent out for whole rock geochemical analysis by ACT labs.

Results

•Columnar basalts cover the top third of the hill. A debris flow scarp exposes two contact zones; one between basalt and diatreme, the second between diatreme and contact breccia.

•The columnar basalts have a trachytic texture near the top of the hill.

•Features including autobrecciated basalt clasts, shale xenoliths, carbonate cement and pyroxene and olivine phenocrysts are all present at Trimble Knob.



Conclusions

•Trimble Knob underwent a two stage eruption; the first being violent, transporting much older rocks to the surface, creating the diatreme, while the second eruption was calm, creating columnar basalts within dikes exposed at the top of the hill.

•The side of Trimble Knob with visible shale outcrops (east) is better exposed than the west side, evidence for a division between the Ridgeley Sandstone and Millboro Shale running north to south, through the hill.

•Trimble Knob appears to be part of a root zone, constrained between numbers 1, 3 and 7 in Figure 1 and in the yellow highlighted box in Figure 2.

•There are two contact zones visible at Trimble Knob. The first is between columnar basalt and diatreme, while the second is further down the hill, between the diatreme and contact breccia. The varying texture at the contact between diatreme and contact breccia is visible at number 3 in Figure 1.

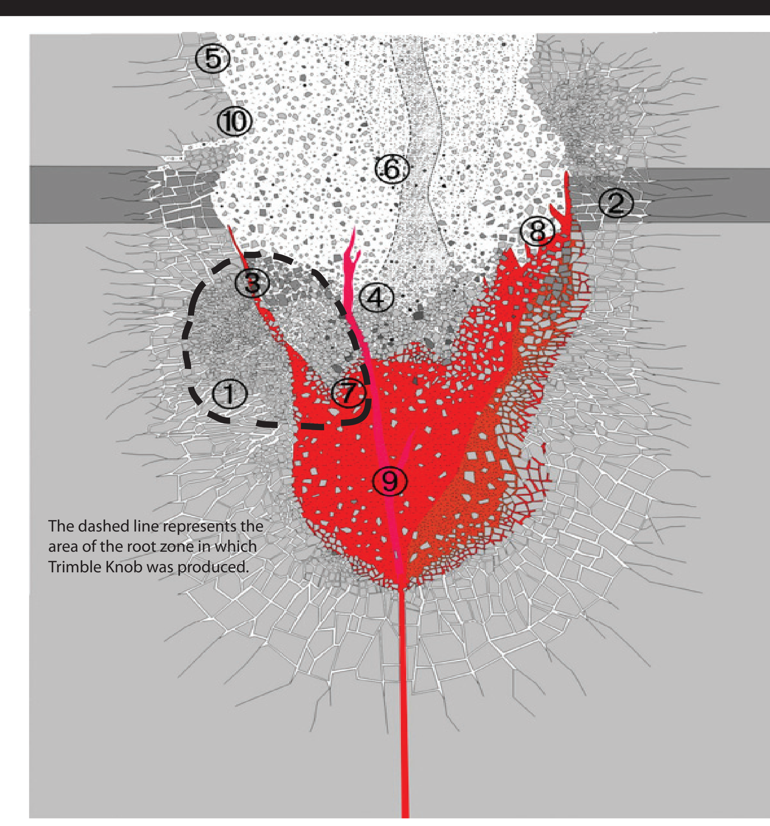


Figure 1: Theoretical diagram of a root zone showing the different contacts between the following rock types. (1) Different contact breccias resulting from a multitude of explosions, (2) contact breccia and subsidence breccia, (3) contact breccia with mass flow breccia, (4) contact breccia and diatreme tephra within the root zone, (5) contact breccia and diatreme tephra within the lower diatreme, (6) different diatreme tephras, (7) contact breccia and intrusive magma, (8) diatreme tephra and intrusive magma, (9) different intrusive rocks, (10) contact of all previous rock types with (almost) unbrecciated country rocks. Diagram from Lorenz "Root Zone Processes" 2007.

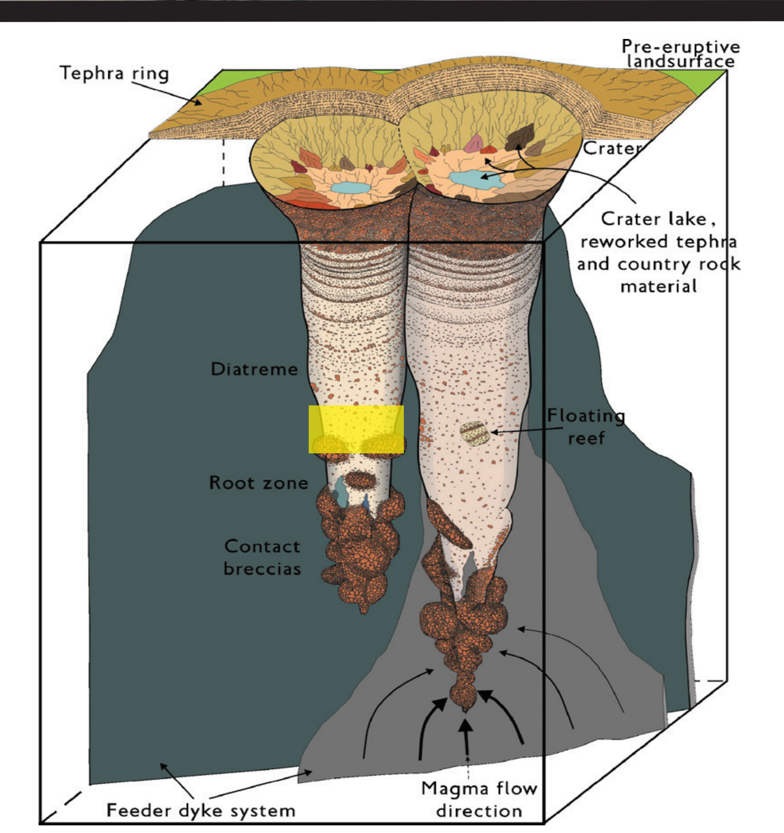


Figure 2: Theoretical 3D model of two maar–diatreme volcanoes which formed on an eruptive fissure system. Each maar–diatreme volcano is shown with its maar crater, tephra ring (only the rear half is shown), regular cone-shaped diatreme (with upper bedded and lower unbedded tephra facies), irregular-shaped root zone, and feeder dike. For the right volcano the syneruptive magma flow in the dike towards the root zone is shown. Each maar– diatreme volcano formed on each own feeder dike. The yellow box places current day Trimble Knob on the diagram. Diagram from Lorenz "Root Zone Processes" 2007.

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