Rockin' New Mexico 2005: Virtual Field Trip—Group 1

Porphyritic Dikes of the Sierra Blanca Igneous Complex
Dr. Richard Chamberlin instuctor

Geologic Overview

The Sierra Blanca Igneous Complex formed as a cluster of stratovolcanoes above the subducting Farallon plate during Late Eocene to Oligocene time (approximately 38-33 m.y. ago). The magmas formed by flux melting of the mantle and then ascended into the crust along an arcuate, north-trending, concave-to-the-west, intrusive belt? the Sierra Blanca-White Oaks porphyry belt. A relative northward motion of the large crustal block, located west of the porphyry belt, is hypothesized to have caused the blocks to locally pull apart and facilitate the rise of magmas. Younger intrusions, 26-27 m.y old, in the region (e.g. Capitan pluton) trend East-West and probably reflect initial relaxation of regional NNE-directed compression, which in turn signaled onset of extension along the Rio Grande rift.

The Sierra Blanca volcanic pile consists primarily of porphyritic lavas and breccias of intermediate composition (andesite and dacite). Plagioclase feldspar is the dominant phenocryst (visible crystalline phase); pyroxene and amphibole phenocrysts are typically less abundant. Dikes (magma-filled fractures) that cut across the volcanic pile are compositionally and texturally similar to the lavas. Some dikes appear to radiate away from the highest peaks.

Geologic Sketch Map of Stop 1 Area (includes road cut)

Tick marks and numbers indicate direction and angle of inclination (from horizontal) for the dikes. Overlying lava flow is inclined (dips) 22° to the ESE.

Background Information for Porphyritic Dikes

This stop examines porphyritic rocks of the Sierra Blanca Igneous Complex that are well exposed in a road cut about three miles west of the town of Alto, NM (see geologic map). Three porphyritic dikes are exposed in the road cut (see geologic profile); the dikes are the emphasis of study for Group 1. The dikes are tabular, near vertical structures that form light colored bands rising through the purple andesite porphyry. The latter comprises most of the road cut (see Group 2). The dikes represent magma-filled fractures that propagated upward and outward from highly pressurized magma chambers. At the time of intrusion, the large visible crystals (phenocrysts) were suspended in the liquid magma. The original silicate liquid (magma) now forms the fine-grained matrix of these rocks. Phenocrysts formed by relatively slow cooling at depth, prior to intrusion. Porphyritic textures represent slowly formed crystals that were carried upwards in a liquid that cooled more rapidly, at or near the surface of the earth. . Therefore, porphyritic textures are distinctive of volcanic rocks or shallow magmatic intrusions. Dark colored chilled margins are distinctive aspects of shallow dikes; some chilled margins are glassy (but not here). Pre-existing phenocrysts are normally present in the chilled margins. Picture captions below represent a group effort.

The dikes show:

- Porphyritic textures large visible crystals in a finer-grained matrix

•Chilled margins dark bands with a very fine matrix, adjacent to the purple porphyry
•Flow banding thin streaks parallel to the dike walls
•Near vertical orientations and Northwest-Southeast trends
•Columnar joints hexagonal prisms that form perpendicular to the cooling surface (i.e. dike walls; hence columns are nearly horizontal)
•Different thicknesses measured perpendicular to walls
•The thickest dike (7m) has a sugary microcrystalline matrix near its center; hence it is called a microdiorite porphyry. However, the waxy looking chilled margins of the same dike are classified as andesite porphyry. Note that diorite and andesite are compositionally equivalent rocks, with different textures.
•Visible crystals (phenocrysts) consist of light colored plagioclase feldspar and less abundant (smaller) crystals of dark colored pyroxene
•Phenocrysts in the dikes are smaller than phenocrysts in the purple porphyry lava flow, which is transected by the dikes (see Group 2)

Features Data

1) Microdiorite Porphyry Dike (Student title: Flow-banded microdiorite porphyry dike)
Location: UTM zone 13 S, 0431825E/ 3694740N (1927 NAD)
Light brown microdiorite porphyry dike forms wide band cutting up through purple andesite porphyry near middle of the road cut. Margins of dike the have an aphanitic matrix and are classified as andesite porphyry. Aphanitic means the matrix is too fine to see individual crystals. Apparent step over of dike at bench level is an illusion caused by the oblique geometry of the road cut, relative to the trend of the dike.

2) Andesite Porphyry Dike, Offset by Fault (Student title: Shift in flow-banded dike)
Location: UTM zone 13 S, 0431780E/ 3694745N (1927 NAD)
Light gray andesite porphyry dike, about I meter thick, cuts across purple andesite porphyry near west end of road cut. Near the top of the cut (mostly obscured by bush), the dike has been shifted about one meter to the left by a normal fault that dips to the southeast. Dike trends northwest.

3) Andesite Porphyry Dike, Chilled Margin and Vertical Flow Foliations (Student title: Vertical flow foliations)
Location: UTM zone 13 S, 0431780E/ 3694745N (1927 NAD)
East margin of andesite porphyry dike showing light brown chilled margin and vertical flow foliations. The latter form thin white streaks in the moderately phenocryst rich andesite dike. Flow bands parallel the chilled margin. Dike trends NNW and is about 1 meter thick. Blades of grass provide a sense of scale. Chilled margin is about 1 cm wide.

4) Andesite Porphyry Dike, Flow Bands and Phenocrysts (Student title: Flow Bands and phenocrysts)
Location: UTM zone 13 S, 0431780E/ 3694745N (1927 NAD)
Close up view of varicolored flow bands near the center of the andesite porphyry dike. Moderately abundant (5-10 % of total volume) plagioclase crystals (white rectangles) are about 1-4 millimeters long. Crystals are aligned parallel to the flow bands that formed by viscous shear in the grayish

brown fluidal matrix.

5) Microdiorite Porphyry Dike, Elbow in West Wall of Dike (Student title: Microdiorite porphyry dike with elbow)
Location: UTM zone 13 S, 0431825E/ 3694740N (1927 NAD)
NNW-trending microdiorite dike is about 7 meters thick. Box outlines horizontal elbow where the dike wall steps about 1 meter to the west. A smaller shoulder on the east wall of the dike also steps left; the subtle shoulder is exposed above the upper bench (arrow).

6) Microdiorite Porphyry Dike, Columnar Joints and Spheroidal Weathering (Student title: Columnar features of microdiorite dike)
Location: UTM zone 13 S, 0431825E/ 3694745N (1927 NAD)
At top left is the end view of a hexagonal column delineated by the arrows. The polygonal fracture pattern (columnar joints) formed as the fracture filling magma cooled slowly inward and decreased in volume. Cooling joints are similar to shrinkage cracks in dry mud flats. Underlying columns have been rounded by spheroidal weathering, which commonly occurs in granitic rocks characterized by visible crystals in the matrix. White specks, below the arm, are plagioclase phenocrysts.

7) Andesite Porphyry Dikelet (Student title: same)
Location: UTM zone 13 S, 0431828E/ 3694745N (1927 NAD)
Andesite porphyry dikelet (small dike) exposed on upper level about 3 meters east of the microdiorite dike. Proximity and similarity of texture to andesitic margin of the microdiorite suggests the two dikes are physically continuous at depth (under bench). Dikelet pinches out about 1 meter above the field of view.

8) Andesite Porphyry Dikelet, Chilled Margin and Porphyritic Textures (Student title: "Cooled" margin between dike and flow)
Location UTM zone 13 S, 0431828E/ 3694745N (1927 NAD)
Abrupt change in size and abundance of white plagioclase phenocrysts defines the intrusive contact along the western side of the dikelet. The subtle chilled margin (below and left of penny) is slightly darker and contains less phenocrysts than the core of the dike. Contrasting textures between the purple porphyry lava and the andesite dikelet indicate their source magmas had different cooling histories.

9) Porphoritic rock (lava, see Group 2) (Student title: same)
Igneous rock composed of large crystals in a fine-grained matrix. Large phenocrysts are plagioclase feldspar.