The photomicrograph below was made from a thin section of the “basalt of Broken Tank” (Chamberlin et al. 2002), a distinctive aphyric ophitic basalt in the Socorro, New Mexico, region of the Rio Grande rift. Geologic and chronologic data indicate the basalt of Broken Tank was erupted onto a gravelly piedmont slope near San Antonio about 8.5 m.y. ago and then flowed 12 mi northward into an intermittent lake basin (playa) near Socorro. Where interbedded in playa muds, the same 8.5 Ma ophitic basalt was initially called the “basalt of Bear Canyon” (Osburn and Chapin 1983), a formation name now abandoned (Chamberlin et al. 2002).

The photomicrograph was made with cross-polarized light in order to reveal a distinctive ophitic to subophitic texture. Ophitic texture is characterized by plagioclase laths (gray and white) largely or entirely enclosed in pyroxene (p) grains (Jackson 1997). Individual crystals of pyroxene (p) are here defined by their uniform interference colors (light brown, dark gray, blue-red, and orange). Subophitic is the igneous texture involving plagioclase laths only partly enclosed by pyroxene grains (Jackson 1997). Relatively large and conspicuous crystals (phenocrysts) are notably absent in this aphyric basalt. Most basalt flows contain sparse olivine phenocrysts approximately 1–2 mm long.

In cross-polarized light, the interference color (birefringence) of different mineral species and of each individual mineral grain (crystal) is determined by the unique optical properties of that mineral species—in conjunction with the optical orientation of that particular crystal within the thin section. The optic axis of the dark-gray pyroxene crystal (near middle of frame) is nearly perpendicular to the plane of the thin section, which allows concentric compositional zones (greenish bands) to be observed. The zoned crystal demonstrates that the bulk composition of the residual liquid (magma) was changing during the crystallization process, a common expression of magmatic differentiation. Thin white lines have been drawn around the larger (~1 mm) pyroxene crystals to show their extent, overall prismatic shape, and relationship to enclosed or partially enclosed feldspar crystals. In three dimensions, the subophitic pyroxene crystals and elongate plagioclase laths must form an interlocking array that causes this dense lava to be extremely elastic and difficult to fracture, even when forcefully struck with a large sledge hammer (a distinctive field characteristic of the basalt of Broken Tank).

The fine crystal size, lack of distinct olivine phenocrysts, and ophitic texture of the Broken Tank lava flow implies that the source magma was superheated (above or at its liquidus temperature,
Ophitic textures are best explained by contemporaneous crystallization of pyroxene and plagioclase from a liquid of equivalent bulk composition at a unique eutectic point or cotectic line determined by the composition and temperature of the melt (Philpotts and Ague 2009, pp. 199–200). At a eutectic point, crystal growth faces must accommodate the relative growth habits of each phase. As shown here, pyroxene within the large ophitic crystals appears to be anhedral, against elongate plagioclase laths, but the exteriors of the large pyroxene crystals are relatively euhedral, against the residual liquid (plagioclase-rich groundmass). Eutectic or cotectic crystallization of basaltic magma occurs between about 1,280° and 1,200°C and produces large ophitic or subophitic pyroxene crystals that contain subequal proportions of plagioclase and pyroxene (Philpotts and Ague 2009, pp. 200–226).

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—Richard M. Chamberlin
Emeritus Senior Field Geologist
New Mexico Bureau of Geology
and Mineral Resources