Amygdale

Amygdales (also known as amygdales) are gas cavities, or vesicles, in igneous rock (usually volcanic or shallow intrusive) that are filled, or partially filled, with secondary minerals. These minerals may have a late-stage magmatic origin or, more commonly, may form from postmagmatic aqueous solutions. Common minerals in amygdules include calcite, quartz, chalcedony, chlorite, and zeolites. Regionally, other minerals may be predominant. For example, many of the datolite nodules found in Michigan's Copper Country (see article by Tom Rosemeyer in this issue) occur as amygdules in the Portage Lake Volcanics. Also found in Upper Michigan, particularly in the Keweenaw Peninsula and on Isle Royale, are amygdules of chlorastrolite (a variety of pumpellyite) known as Michigan greenstones, Michigan's state gemstone. Furthermore, one of the important modes of copper formation in the Keweenaw deposits is as amygdules. These deposits formed from hydrothermal solutions that permeated basaltic lava flows and deposited copper and other minerals by open-space filling (i.e., fractures and vesicles) and replacement.

Vesicles are created by the expansion of gas bubbles or steam within molten lava; they are, therefore, usually rounded, elongated, or almond-shaped, like those in figure 1. Vesicles and hence amygdules are generally more pronounced in basalts than in other volcanic rock types. This is partly because of the lower viscosity of basaltic lavas, which allows gas bubbles to readily expand before the lava solidifies. Vesicles are typically an inch or two in maximum dimension; however, they can be much larger. The larger ones are commonly known as pockets or vugs and are less likely to

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Figure 1. The oval features in these photomicrographs (crossed polars, 20x magnification) are amygdules: formerly open vesicles that have been filled with secondary minerals that precipitated from low-temperature ground waters that penetrated the host basalts. The amygdule comprises zeolites on the top; Ninad Bondre specimen. The image on the bottom shows an amygdule with multiple generations and habits of calcite; Brian Currie specimen.

Figure 2. Copper amygdules in basalt, Wolverine mine, near the village of Kearsarge, in Houghton County, Michigan. The specimen measures 11 x 7 x 7 cm. A. E. Seaman Mineral Museum specimen, George Robinson photo.

become completely filled by secondary minerals. If mineralized, they usually exhibit varying degrees of lining. The spectacular museum specimens of zeolites from the Deccan Traps in India (Ottens 2003) are found mostly as amygdules or pocket linings.

In some lavas, rising gas bubbles may stretch out to form tubular vesicles. Mineralization of these vesicles forms what are known as tube or pipe amygdules. Large tubular gas pockets (often many feet long) lined with amethyst and other accessory minerals, colloquially known as “cathedrals,” are common in the basalts of Rio Grande do Sul, Brazil.

The term amygdule is derived from the Greek word for “almond.” There are some ambiguities in the semantics given above. Specifically, the dividing line between what we would call an amygdule and a mineralized pocket, and the degree of vesicle infilling necessary to be called an amygdule, is not precisely defined—although, as already mentioned, vesicles and hence amygdules are usually less than 2 inches in size. Igneous rocks with abundant amygdules are said to have an amygdaloidal texture or fabric. These are common terms used to describe igneous rocks; further information can be found in most books on igneous petrography and petrology (i.e., Best 1982).

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