Musings on granite rocks

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Granite rocks have always fascinated me. I was interested in understanding how these were formed and found in peculiar arrangements all over. Most researchers think granite rocks are formed by cooling of magma. It is not a very convincing argument. The western ghats of Maharashtra is a result of deposition of magma, and its high iron content (almost 25%) gives it a black colour.

Granite rocks are found in all parts of the world. They are homogeneous, hard (6-7 on the Mohs scale), dense (about 4 g/cc), and mainly composed of silica and feldspar, with traces of elements such as iron (which provide colour). They are mixtures of glassy and crystalline phases and can take and retain excellent polish. The texture, porosity and shades of granite rocks vary from place to place.

In India, granite rocks are found in several States, primarily Karnataka, Andhra Pradesh, Maharashtra, Madhya Pradesh, Rajasthan, and Tamil Nadu. You must have seen them in the famous Hindi films *Sholay* and *Quayamat se Quayamat Tak*. The stone has been cut and polished in India for over 2500 years. The Meenakshi temple at Madurai, and the carvings at Mahabalipuram, near Chennai, are but a few examples of artisans working granite. There are more than a thousand large and small temples in South India that bear testimony to the art and science of our ancestors.

In nature, granite often occurs in the strangest of places. In a field of black cotton soil, one suddenly finds a large rock of totally unrelated composition standing beautifully, supporting another rock of almost equal weight. Sometimes these are very large – as much as 1-km in diameter. The entire mountain of the hill station Kodaikanal is situated on one such rock. The Vivekananda Rock at the southernmost tip of India also stands on a large granite rock at Kanyakumari, while the Gomatagiri statue of Bahubali is a monolithic structure of granite. [Sadly, destruction of granite deposits is happening unchecked, and we could in time have nothing to show future generations. It is time these structures are declared as world heritage and protected].

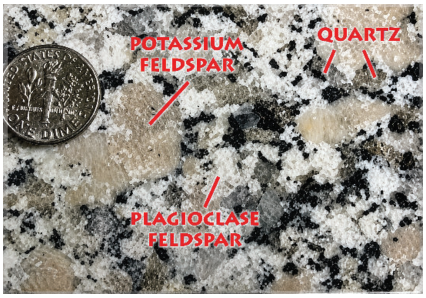
Granite outcrops of Yosemite
[El Capitan is seen on the left, Half Dome in the distance]

Structural features

There are some striking structural features unique to granite.

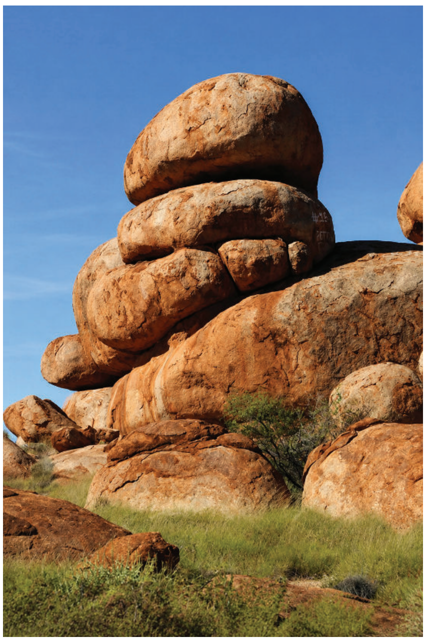
Irrespective of size – ranging from a few meters to a few kilometres – most are nearly spherical, except those placed on top of another rock. The ones that are smaller and scattered are very nearly spherical.

Their internal structure is very uniform. The grain pattern, colour, texture and porosity are almost the same from the surface to the core. It appears to have been sintered but not fused. I have



Minerals in a polished slab of granite

Jointed granite - Olmstead Point, Yosemite. (Notice the curvature)



Granite rocks at Hampi, Karntaka

rarely seen bold crystals of quartz embedded in a granite rock.

The mineral composition of the surrounding clay near a granite rock is very unlike the rock. For example, in Karnataka, the clay surrounding the rock is rich in iron, but the granite just has traces of iron.

This poses some hitherto unanswered questions: What is the origin of Granite? How come there are no bold crystals of quartz found?

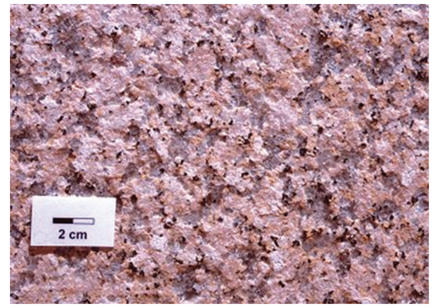
The origin of granite

Granite is the name used for a variety of light-coloured, coarse-grained igneous rocks. It is thought to be the most abundant rock type of the continental crust. However, because it crystallizes at depth it is exposed at the surface at only those locations where deep erosion has taken place.

Orthoclase (potassium) feldspar is typically the most abundant mineral in a granite and significant amounts of quartz and plagioclase feldspar are generally present. Minor minerals include muscovite mica, biotite mica, and hornblende, among others. Light-coloured, igneous rocks such as granite, are frequently referred to as 'felsic' rocks.

Granite aggregate

Granite quarry where large dimension stone granite is produced [Notice uniformity of the structure and total absence of gas bubbles.]



Pink granite

Granite bench

The coarse grain size of granite indicates a slow rate of cooling below the earth's surface. The insulating effect of the surrounding rock caused the magma to crystallize very slowly. The slow cooling allowed the mineral grains adequate time to grow to a large size.

Uses of granite

Granite is a very durable stone and is used in a variety of ways. Its attractive appearance makes it useful as an architectural stone. It is also widely used in monuments, grave markers, stair treads, counter tops, windowsills, and street curbing. The solid blocks of granite are cut from the earth at a granite quarry.

Granite is also used in the form of crushed stone or aggregate, mainly for road construction and maintenance, but also as landscaping stone and paving. The U.S. Geological Survey estimates that granite accounts for about 16% of the United States crushed stone production, only behind limestone and dolomite.

The uniformity in the structure of granite raises many questions:

1. If it is a product of volcanic eruption, why is there no trapped gas? Trapped gas is almost always seen as cavities in the basalt found in the Deccan. When there is trapped gas, it leads to formation of bold silica crystals. An excellent collection can be seen at the Gargoti Museum, India's only museum dedicated to gems, minerals, and fossils.

2. Why can't bold crystals of quartz or feldspar be seen anywhere in granite rocks?

3. Why do most rocks look spherical or nearly spherical? In the Yosemite picture there is a mention of 'Half Dome'. To me it is a spherical rock which broke into two. If we look around, we might find the other half, unless it has been used up.

I have no answers to these questions. I only want to put forward a hypothesis that would need confirmation and research.

Is granite extraterrestrial?

I suspect all granite to be extraterrestrial. It might have entered the earth at a time when the temperature was about 800-900°C. The atmosphere at that time would contain almost all the carbon as carbon dioxide (CO_2), all water as a vapour, and nitrogen, sulphur dioxide and several other elements that were not present, as oxides. Most of the elements could have existed as metal oxides, chlorides and sulphates. If we convert the entire carbon on earth to CO_2 and water to vapour, based on the relative abundance of the elements, the atmospheric pressure would be in excess of 15-kg/cm^2, with about 7-kg/cm^2 of CO_2 pressure. The atmosphere would also have extended well above where it is today.

This factor needs to be considered while trying to trace the origin of all minerals we see on earth today. For example, calcium carbonate decomposes at about 800°C. Cement and lime industry uses it and dissociates it to calcium oxide. Those of you who have seen crystalline calcite would realize that such bold crystals (up to 1 meter or more per piece) cannot be a result of hydrothermal process commonly believed.

Calcite is the stable form of the widely distributed mineral, calcium carbonate ($CaCO_3$). It is noted for its beautiful varieties and perfect crystals. Calcite is the primary mineral component of limestone and its metamorphic form, marble. It is very soluble in groundwater and is common in the shells of invertebrates like clams and oysters. A large percentage of the calcite in rocks was deposited in sedimentary environments of both chemical (limestone) and biochemical (chalk) origin. Calcite clastic rocks consist of transported fragments from previously deposited, biologic materials (calcarenite). A small amount of calcite is of igneous origin and is the primary component of the rare rock called calcite carbonatite. [Ref: http://www.desertusa.com/mag98/nov/papr/geo_calcite.html]

At 7-kg/cm^2 CO_2 pressure and a temperature of 1500°C even calcium carbonate melts. Bold crystals can result from slow cooling of the melt. This could be the reason behind formation of marble.

There are some volcanic minerals, called "cementitious" for their chemical composition. If these are burned at clinkering temperature, they can directly form cement clinkers without adding any corrective material. A question arises: if the rock has cementitious composition and the temperature was also adequate to form clinker, then why not mine clinker itself? The reason is the high CO_2 pressure.

Similarly, the extraterrestrial mass entering the earth in a dense atmosphere would result in its uniform heating and the high temperature of the earth would aid slow cooling, thus allowing formation of a uniform structure.

Formation of oil deposits

The present hypothesis can also explain the formation of oil deposits. At a CO_2 pressure of 7-kg/ cm^2, the vegetation would be very different from now when the CO_2 concentration is just about 440-ppm. (There are reports of algae that produce high concentration of oily substance close to thermal power stations emitting large amounts of CO_2). The Mineralogy Department at Government Science College, Jabalpur, have fossils that show the presence of grass almost 3-4 meter long.

The cooling of the earth might have started from poles since these receive much less energy from the sun compared to the equator. The large quantities of hydrocarbons, gums and resins produced by vegetation there could have travelled to other parts of the world with water, as the moisture condensed on cooling. It is very interesting to note that rosin-like resins have be excavated from mines of lignite. I have seen such specimen in Kutch lignite and am told that workmen there regularly take it away as *Guggal*, a gum used for *dhoop*. Even today, the difference in temperature between the poles and equator is in excess of 100°C. Which means there are huge, untapped reserves of oil and coal on both the poles.

These factors need to be considered while looking at the formation of several minerals on planet earth. I am sure geologists would find some new clues!