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Granite formation: catastrophic in its suddenness

Tas Walker

'In fact, just about everything that was taught as recently as ten years ago about granitic magmatism has been turned on its head.'[1]

So concludes John Clemens in his overview paper about the origin of granite, published in the UK in the Proceedings of the Geologists' Association.

In his introduction to Clemens's paper and the accompanying discussion, editorial board member W.J. French explains that the origin of granite has been controversial since before James Hutton (1726–1797). After summarizing the turbulent disputes through the 1950s and up to the present, French boldly proclaimed that with Clemens's paper, 'The granite controversy ends'!

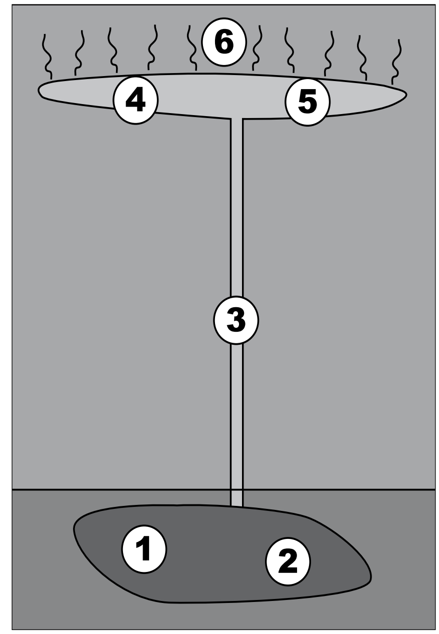

Figure 1. Model for the origin of granite: (1) partial melting of source rock deep inside the crust, (2) separation of magma from solid residue, (3) transport of magma in dykes to upper crust, (4) accumulation of magma into tabular pluton, (5) crystallization of pluton, and (6) cooling of pluton.

Conflict with the Bible

For more than a century geologists have accepted that granites formed slowly over millions of years. Any suggestion that the biblical account with its 6,000-year timeframe be taken seriously has been dismissed as nonsense.

Geologist Paul Blake, in the newsletter of the Australian Geological Society, argued exactly that—that granite formation means that any geological model based on 'the Bible's flood myth' is absurd, and 'all the available evidence contradicts such ideas.'[2] He illustrates his point using granite outcrops:

> 'Field relationships [in this area of Australia] show that there are two entirely separate granitoid intrusive events in the sequence, each of which require at least 3,500 years to cool. How does Dr Walker fit 7,000 years worth of granitoid cooling into 60 days? Unless Dr Walker can find a way to emplace, cool and unroof granitoids within a couple of days then his model does not stand up to scrutiny.'[2]

But, according to Clemens, slow-and-gradual ideas about granite formation are wrong:

> 'The long-cherished picture of granitic diapirs [balloons of magma] slowly pushing their way toward the upper crust and grinding to a halt by solidification has been replaced by an altogether different picture of narrow feeder dykes punching their way upward in months, pulsing with magma and feeding rapidly growing plutons.'[1]

Surprisingly, Clemens suggests that belief in an old earth has long led thinking down the wrong path. He claims that the idea the earth is 4,600 million years old had 'a psychological effect of tempting one to consider geological processes as slow and continuous. After all, there is all that time to fill.' He concludes that granites belong with increasing number of geological processes that were 'catastrophic in their suddenness'.

Clemens has researched igneous rock-forming processes most of his professional career. He specialised in crystalline rocks, particularly granites, and applied field, geochemical, isotopic and experimental approaches to understanding their origin.

One of the contributors invited to discuss Clemens's paper, Wallace Pitcher, took mild exception to the idea that Clemens's views are new. Pitcher, who had researched the granite problem for over 60 years, said he had 'long abandoned the idea of vertically extensive, deep-seated pyramidal batholiths, envisaging instead dyke-interconnected magma chambers, themselves filled pulsively.'[3] Note the word 'pulsively', suggesting crustal dynamics were involved.

The whole thrust is that granites form quickly, much faster than previously imagined, something that creationists have previously reported.[4]

Magma production

Granite magma is the result of melting or partial melting of a pre-existing source rock (figure 1). The second step is that the melt must be separated from the solid residue and collected into bodies. The evidence points to the process of melt segregation being rapid.[5]

Clemens explains that metamorphic rocks of the granulite facies[6] are considered to be the solid residue from the process of partial melting and melt segregation. So, since the granitic magma was produced rapidly, then the associated metamorphism was also rapid. The mineral transformations that occur during metamorphism are the result of chemical reactions, and these need abundant water to allow the free exchange of ions. With the appropriate physical conditions chemical reactions proceed quickly.

Magma transport

Also, since the melts are produced deep within the crust, the magma must have travelled tens of kilometres upward. How this occurs depends in part on the physical properties of the melts, which can be quite complicated. Some of the findings have been surprising.

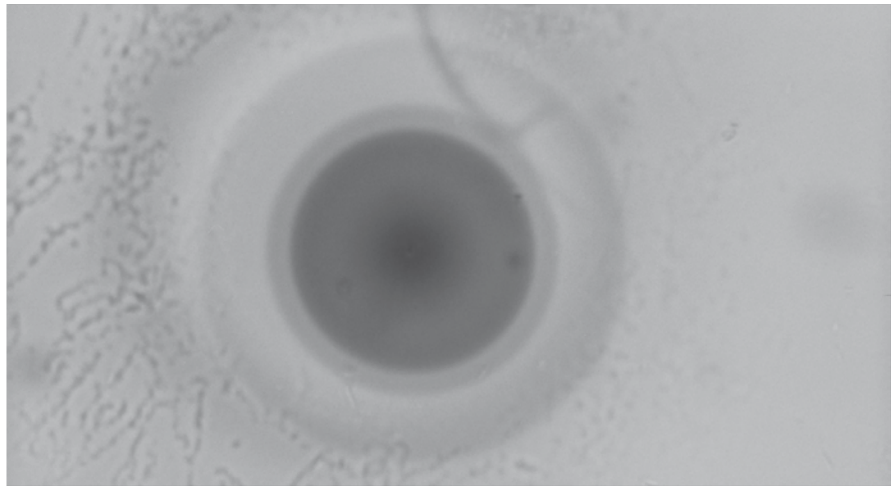

Figure 2. A polonium halo. (Photo by Mark Armitage).

Viscosity calculations have shown that the flow properties of granitic magma remain relatively unaffected by the presence of crystals.[7]

Furthermore, for magma to ascend to the surface it is found that the critical widths of the dykes are quite small, of the order of 1–2 m only. In other words, narrow dykes can be very efficient transporters of granitic magma in the crust.[7]

With the dyke model, the ascent rates of granitic magma could vary by less than 10% over a broad compositional range.[7]

The crystals that form in granitic magma can actually resorb during and after ascent. This means that any remnants of the source rock (resistite) could be destroyed during ascent causing the magma viscosity to lower. In fact, the ascent rate could increase during ascent, meaning that the magmas would accelerate rather than slow down.[7]

Magma can be transported through pre-existing structures such as faults and joints. However, pre-existing structures are not necessary because the buoyancy of the magma in vertical cracks will cause the cracks to propagate. Any sudden failure of the wall rock would lead to an upward migration of the crack tips and an upward flow of the magma.

So how long does it take for magma to ascend 20 km in the crust? With typical magma and crust properties it could be anywhere between *five hours* and three months. Clements says:

> 'Such rapid ascent rates are clearly negligible on the scale of geological time. This would make granitic magma ascent effectively an instantaneous process …'[8]

What sort of time would it take to build a huge pluton? According to Clemens, a dyke 3 m wide and 1 km long (in plan) could build a batholith of 1,000 km^3 in 1,200 years.

While this is longer than the biblical timescale, remember that that Clemens is working within the uniformitarian paradigm of a 4.6-billion-year-old earth. A period of 1,200 years is probably the longest he could comfortably stretch the time. A slightly modified combination of parameters (such as dyke dimensions, magma viscosity and fluid content) would make the biblical timeframe even more plausible. 'Huge batholiths could be created quickly with relatively small dykes or pipes that tap magma sources many kilometres to tens of kilometres below.'[8]

Clemens describes how the crystals in some granites are arranged in patterns resembling textures in sedimentary rocks: graded-layering, cross-layering, scour and fill structures, flame structures and swirls or enclaves of crystals.[9] According to Clemens these 'attest to the fluid character of the magma'. But they do more than that. They point to the fact that the magma was flowing when the crystals settled, and that the flow was pulsing. These support the concept that the batholiths filled quickly during times of tectonic disturbance.

Magma crystallization

Another idea that Clemens 'turns on its head' is that the large crystals in granite grow slowly over long periods of time. This has long been used as an argument against the reliability of the biblical timescale, but it has been refuted before.[10] Clemens too notes that crystallization can be much faster than previously imagined possible:

> 'Experimentally measured rates indicate that a 5 mm crystal of plagioclase could have grown in as short a time as 1 hour, but probably no more than 25 years.'[11]

Pluton cooling is another geological process that has been said to take millions of years, but geological understanding of pluton geometry no longer supports this. Recent geological and geophysical observations have revealed that the world's granitic plutons are mostly tabular in shape and typically only a few kilometres thick. This runs counter to the old idea of vertically extensive batholiths, but this is now accepted as an observational fact.[8]

Given this tabular shape, it is a simple matter to model the cooling by conduction of a 3 km sheet of granitic magma.[8] Based on conduction alone (i.e. ignoring the cooling effect of fluids) it would take only 30,000 years to completely solidify from the initially liquid magma. But we know that fluids play a controlling role in the cooling of granitic magma, and their behaviour would drastically reduce the time.[12]

Rapid crystallization and cooling is also indicated by the presence of tiny spheres of radiation damage within biotite crystals in granite. Halos produced by polonium (figure 2) are abundant in granites, pointing to catastrophic geologic processes on a young earth.[13,14] Clemens did not mention this remarkable evidence, but it further confirms the general thrust of his paper.

Pitcher agrees with Clemens's conclusions about the shape of granitic plutons, quipping that 'the single towering body was an offence to reason.'[15] He also pointed out that a thin geometrical shape 'is consistent with the remarkably low degree of contact metamorphism against bodies of considerable outcrop area.'[16]

More and more consistent with the biblical timeframe

Clemens's overview of the latest findings on the origin of granite demonstrates that the geological evidence is leading to models that are consistent with the biblical record.

But there are still important unanswered questions. Why do granite rocks form in the first place? What initiates the melting of the source rocks? This is where the biblical model of the Genesis Flood provides a simple but elegant explanation. The enormous tectonic upheaval involved is sufficient cause—from beginning to end. Global scale catastrophe created continental scale crustal movements that initiated partial melting deep inside the earth, forcing the magma through the crust, and emplacing it in huge magma chambers—all quickly. We do not see granitic magma being produced and emplaced on these scales today.

In spite of the revolution in thinking about granite discussed in the Geologists' proceedings, and the recognition of granitic casastrophism, the authors nowhere suggest that the age of the earth should be questioned, even though they recognize the harmful psychological effects of the long-age paradigm. This problem was not recognized or explored. But, now that they have extended geologic casastrophism from sedimentary rocks to igneous (and, by association, metamorphic) ones, where do they propose inserting the billions of years of time?

'Obvious truth is rarely as obvious as one thinks.'[11]

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