World War. After this time, the Tunnel was forgotten until 1965 when it was explored by the Shropshire Mining Club. Now, visitors can enter the first 100 yards where the bitumen can be seen oozing through the joints between the bricks. On the right hand side, two tar wells can be seen and a channel runs along the same side to drain the tar away. The rest of the Tunnel is not accessible to visitors but, beyond the iron gate at the inner end, the Tunnel opens out to allow wagons to pass. Beyond there, the Tunnel has collapsed and, a little further on, becomes no more than a culvert but it had been wider and longer in its operational days, having been reported to be 1100 yards in the 1790's.

Brea Tar Pits, famous for the huge number of preserved fossil animals from mice up to large mammals that had fallen into the bitumen ponds over thousands of years, is the largest of its kind. So, it was a pleasure to find that we had a similar phenomenon in this country, albeit on a very small scale. The Tar Tunnel of Ironbridge has no fossilised creatures although the odd spider and woodlouse seem to have been lured into the bitumen but it was a very interesting visit and recommended if you are in the Ironbridge Gorge.

JOURNAL of an AMATEUR GEOLOGIST: STONE MOUNTAIN, GEORGIA, USA

Roger Southgate

In a park to the east of Atlanta stands Stone Mountain, (Fig 1) a rounded mass of "granite" about 2.5 km long rising 250 metres above the surrounding plain. The park, which is a Confederate Memorial site, is easily accessible from the interstate road network around Atlanta.

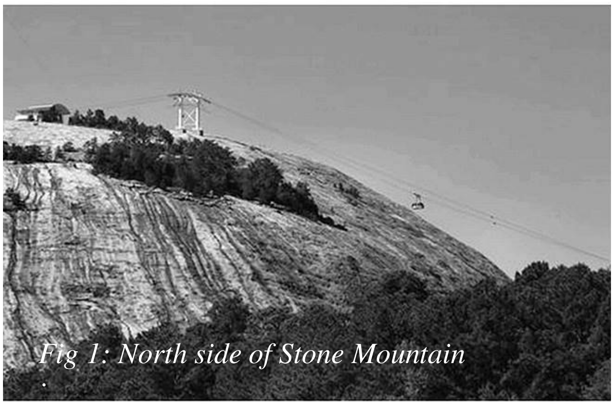

Fig 1: North side of Stone Mountain

The State of Georgia is located in the south-eastern region of the USA. The sketch map at fig. 3 shows the location of Stone Mountain and the provinces of the northern half of the state. The Valley and Ridge, Blue Ridge and Piedmont provinces form part of the Appalachians which extend from Newfoundland to Alabama.

The main visitor attraction is a memorial carving about half-way up the side of the mountain (Fig 2). It is almost 60 metres long and 30 metres high and depicts three figures on horseback associated with the succession of the Confederate States and subsequent American Civil War (1861-1865). The

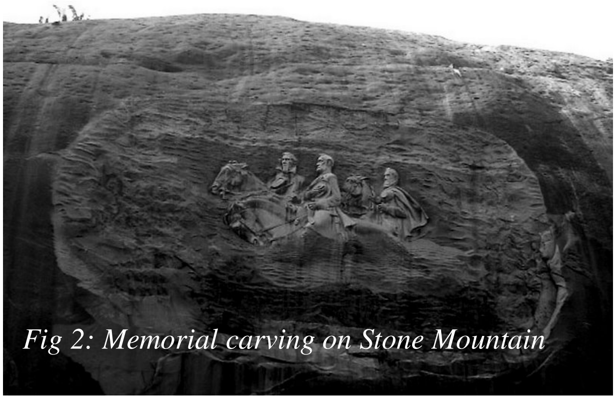

Fig 2: Memorial carving on Stone Mountain

carving was started in the 1920s and, after a long interruption, finally finished at the beginning of the 1970s.

My first visit to Stone Mountain in 1974 was to view this carving and, despite other visits since, I have only recently been able to walk up to the top and look at the geology.

The lower half of the state is part of the Coastal Plain province that stretches around the edge of the eastern part of the USA from Cape Cod in Massachusetts to Texas. The Coastal Plain province is a region of unfolded sedimentary rock and in Georgia it comprises Cretaceous, Tertiary and Quaternary deposits.

The Fall Line is the dividing line between the Piedmont and Coastal Plain provinces. It is significant as it represents a change from the harder rocks of the Piedmont to the softer rocks of the Cretaceous. A number of rapids and waterfalls on the rivers along the Fall Line form a barrier to navigation. As a result, a number of cities and towns were located along this line so that goods could be trans-shipped.

The results of a large seismic-reflection survey of the Appalachian area form the basis of an article in a Scientific American publication (Cook et al, 1980) about the tectonics of the formation of the southern Appalachians.

The origin of the Piedmont province goes back to crustal fragments in an island arc that developed following the rifting of the eastern margin of Laurentia (the proto- North America) during the late Proterozoic. About 500Ma the basin between Laurentia and the Blue Ridge and Inner Piedmont fragments of the island arc began to close as a result of subduction. During the Ordovician the Piedmont accreted on to the eastern margin of Laurentia (Cook et al, 1980); this corresponds to the Taconic orogeny which affected several provinces of the Appalachians.

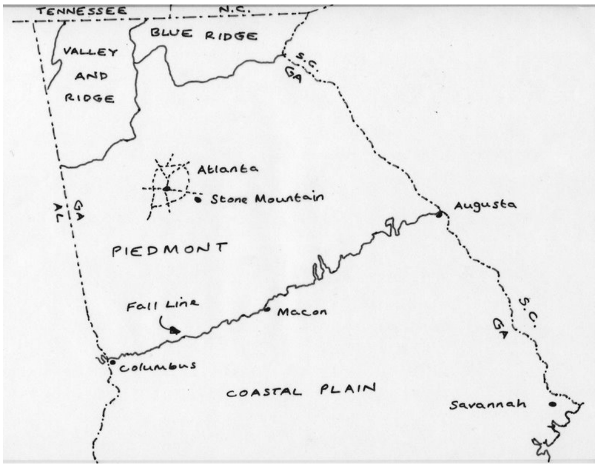

Fig 3: Sketch map of northern Georgia showing Georgia's provinces and the location of Stone Mountain

Some of the rocks in the Blue Ridge and Piedmont provinces have the same radio-active-dating age (about 1000 Ma) as the basement rocks of eastern North America. This suggests that some of the rocks of the Blue Ridge and Piedmont underwent metamorphism at about the same time (Cook et al, 1980). They may therefore have been part of the same crustal block on the eastern part of Laurentia before the rifting began in the late Proterozoic.

The Geological Highway Map (SE Region) shows the Piedmont province as comprising mainly of different types of gneiss of Cambrian or earlier origin. There are a number of major thrust faults trending northeast parallel to the overall trend of the Appalachian Mountains. The topography of the Piedmont province is a gentle rolling plain relieved by isolated hills or ridges of resistant rock. Georgia's Stone Mountain is probable the most well-known but there are a number of others.

Coincidentally, the Geological Highway Map has Stone Mountain as its cover photo. It summarises its "granite" as a muscovite quartz monzonite pluton emplaced during the Permian in a complex of schistose and gneissose rocks ranging in age from late Pre-Cambrian to middle Paleozoic.

Another description of Stone Mountain "granite" (Size and Khairallah, 1989) is: light grey, fine to medium-grained, consisting of quartz, plagioclase, microline, muscovite and biotite. The two descriptions appear to be consistent: microline is potassium (alkali) feldspar; quartz monzonite is located mid-way along the alkali-plagioclase axis of the QAPF diagram for plutonic rocks with 5 to 20% quartz.

An Rb-Sr isochron yielded an age of 291 +/- 7 myr; the most likely source material is the Lithonia Gneiss which underlies the area (Whitney et al, 1976). This age equates to the early part of the Permian (using GTS 2004).

The summit of Stone Mountain can be reached by a 2km walk-up trail from the west end of the mountain and is not too strenuous. A Swiss cable-car system provides a faster alternative, but not so interesting, route.

The surface of the "granite" has cracked and exfoliated in lots of places. In fact the whole mountain could be considered as a giant exfoliation dome (Fig 4). A number of dish-shaped depressions roughly 15-20 cm. diameter are visible in the rock. According to the display

Fig 4: Peeling of the rock on the side of the mountain.

boards in the building at the summit, these were once thought to be caused by lightning strikes but are now considered to be caused by erosion of marginally-softer parts of the rock.

Many tourmaline pods are visible on the mountain (Fig 5) containing crystals that look like a 'cat's paw' with a surrounding area that looks almost bleached.

Fig 5: Tourmaline pod (pen is 14 cm long).

The explanation (Size & Khairallah, 1989) is that the mineral zoning towards the centre of the pod shows a decrease in plagioclase, muscovite and biotite and an increase in microline and tourmaline. The tourmaline pods are interpreted (Size & Khairallah, 1989) as late-stage, post-magmatic zones formed during metasomatism by boron-rich fluids which stripped cations such as biotite while migrating into small low-pressure pockets. That's getting deep into geochemistry and I can't comment! Much of the granite in Devon and Cornwall is tourmalinised in the same way.

Stone Mountain is a pluton that was originally covered by several kilometres of overlying rock. The erosion of the overlying rock would have relieved pressure on the surface of the pluton resulting in the release of some of the internal stresses and causing cracking. Some intrusive structures such as large quartz veins (Fig 6) and tourmaline aplites (Fig. 7) are visible on the mountain. (An aplite is an intrusive rock in which quartz and feldspar are the dominant minerals.)

Several types of xenoliths are present in the rock, including some of biotite gneiss, with sizes ranging up to one metre (Gore, 1999); unfortunately, none were spotted. Granite autoliths are also present; fig. 8 shows one about 1.5 metres long.

Fig 6: Quartz vein about 30 to 40cm wide.

Fig 7: Tourmaline aplite

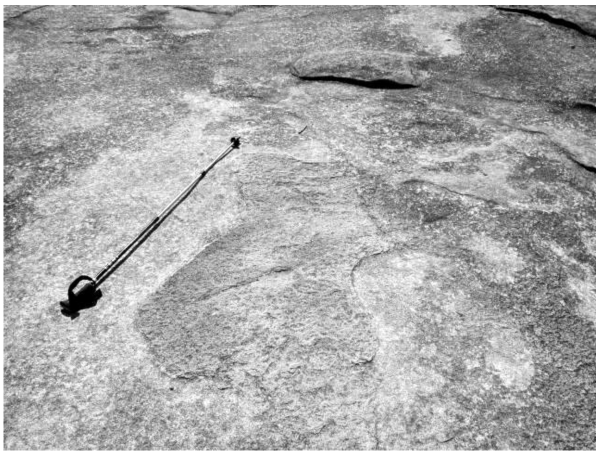

Fig 8: Irregular shaped outline of an autolith, a segregated piece of rock from within the pluton.

A disused quarry at the east end of Stone Mountain has the freshest rock exposures. A display area highlights the history of the quarry starting with quarrying around the time of the American Civil War (1861-1865) extending through to the early 1970s.

The quarry contains a number of intrusive structures such as quartz veins, tourmaline aplites and zoned granite dykes (Fig 9).

Fig 9: Granite dyke about 40 cm wide

To the east of the mountain approaching the nearby lake is a road-cut next to an old highway. The granite here has weathered to saprolite, a residual deposit of mainly white powder (fig 10).

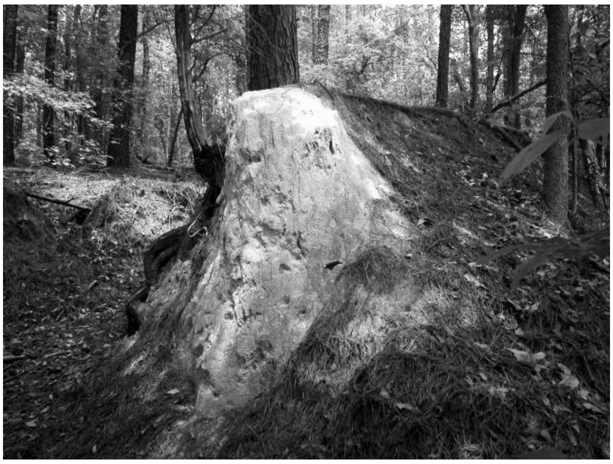

Fig 10: Exposed bank showing granite that has weathered to saprolite

Further along the road-cut towards the lake there is a diabase (dolerite) dyke intruding the granite (Gore, 1999). The existence of the diabase dykes in the Piedmont province relates to the break-up of the super-continent Pangea during the Triassic.
The road-cut is very overgrown and, despite searching for it, the dyke was not located. Iron oxides from the weathering of the diabase apparently result in some of the soil in the area having a brownish-orange colour; soil with that description was found in the area but not the dyke. A follow-up trip is needed!
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Photographs by Roger Southgate

MORE GEOLOGICAL HOWLERS

QUESTION:
What were Stegosaurus' plates used for?

ANSWER:
●They were used like solar panels turning heat from the sun into energy.
●They were to prevent other dinosaurs from jumping onto the creatures' backs.
●They were to make them look nasty and find a mate.
●They were to act as wind supports and stops the Steg from being moved by a strong wind.