

## Meteorite Impactites in London: Irongate House, Houndsditch EC3

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*Irongate House (below) was designed by architects Fitzroy, Robinson & Partners and completed in 1978. It is a building that is quite easy to ignore. Situated at the Aldgate end of Houndsditch in the City of London, this is a now rather dated, 1970s office block surrounded, and arguably encroached upon by the sparkling glass slabs and cylinders of new modern blocks nicknamed the 'Gherkin' and the 'Cheesegrater'. Walking past, at pavement level, it could indeed be dismissed as the entrance to an underground car park. But look up! Irongate House is a geological gem with a unique and spectacular decorative stone used for cladding the façade.*



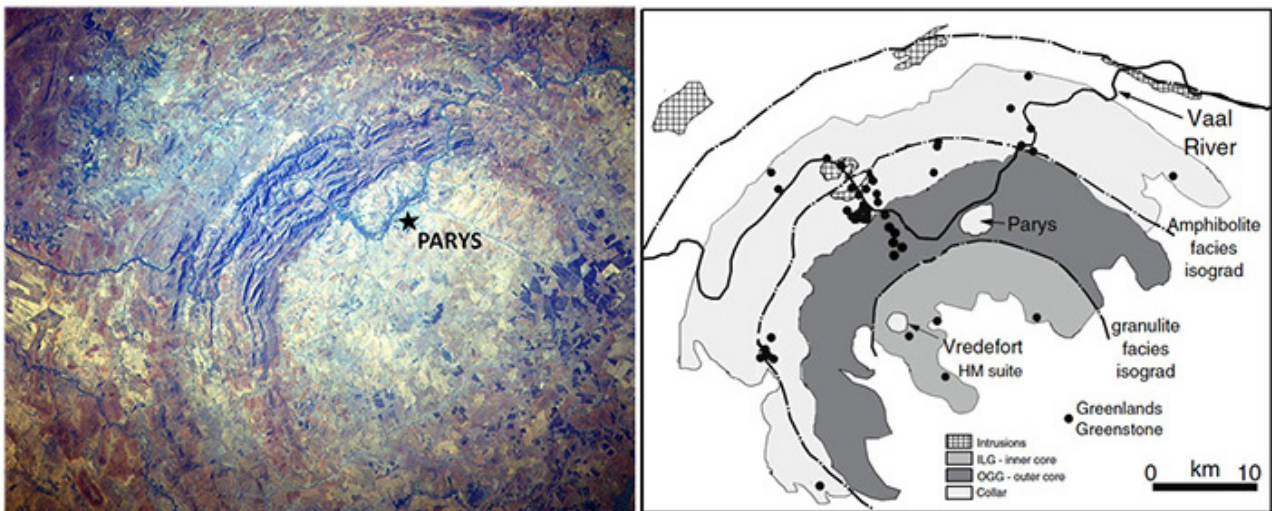
Eric Robinson corresponded with the architects during the building of Irongate House, whilst he was compiling his urban geological walk from the Royal Exchange to Aldgate (Robinson, 1982) and the second volume of the London: Illustrated Geological Walks (Robinson, 1985). Eric discovered that Fitzroy, Robinson & Partners' stone contractors had chosen a most exotic, unusual and unexpected rock, newly available on the market. This is an orthogneiss from South Africa called the Parys Gneiss. What makes this rock more interesting is that the town of Parys, where the quarries are located, is positioned close to the centre of a major meteorite impact crater, the Vredefort Dome, and the effects of this event, melts associated with the impact called pseudotachylites, cross-cut the gneiss and can be observed here in the City of London. Both to mine and Eric's knowledge, Parys Gneiss is used here uniquely in the UK, and as such it also made it into Ashurst & Dimes (1998)'s review of building stones.

The Parys Gneiss was formed just over 3 billion years ago, metamorphosing granites of what is now the Witwatersrand Basin in the Kaapval Craton at amphibolite to granulite facies metamorphic conditions. These rocks represent the lower continental crust. Metamorphism and deformation has created textures that are typical for this kind of rock. It is coarse-grained, with centimetre-sized crystals. The rocks origin as a granite is clear from its mineralogy, being composed of salmon-pink orthoclase feldspar, white plagioclase feldspar, quartz, black biotite mica and hornblende. It shows gneissose textures with alternations between orthoclase-rich and plagioclase-biotite rich bands. These are variably contorted and folded.



Above left; detail of Parys Gneiss. Above right, contorted Parys Gneiss cladding one of the supporting piers of Irongate House.

Located around one hundred or so miles south west of Johannesburg, the Vredefort meteorite impact crater is both the largest and the oldest event of its kind recorded on Earth. The impact took place at 2 Ga (2 billion years ago). When a large meteorite hits the Earth's surface it will excavate a crater, in which the centre rebounds, thus uplifting the most deeply buried rocks. A considerable amount of the crust, and indeed the meteorite itself would have vapourised on impact. The Vredefort impact structure is 90 km in diameter and exposes the Archaean gneiss uplifted in the centre, whilst the rim is composed of vertical to overturned, younger Archaean and Proterozoic rocks. A target-like zonation of the centre, the 'core', reveals the highest grade metamorphic rocks, representative of the lower-most portions of the crust, exposed in the centre, with metamorphic grade decreasing outwards.

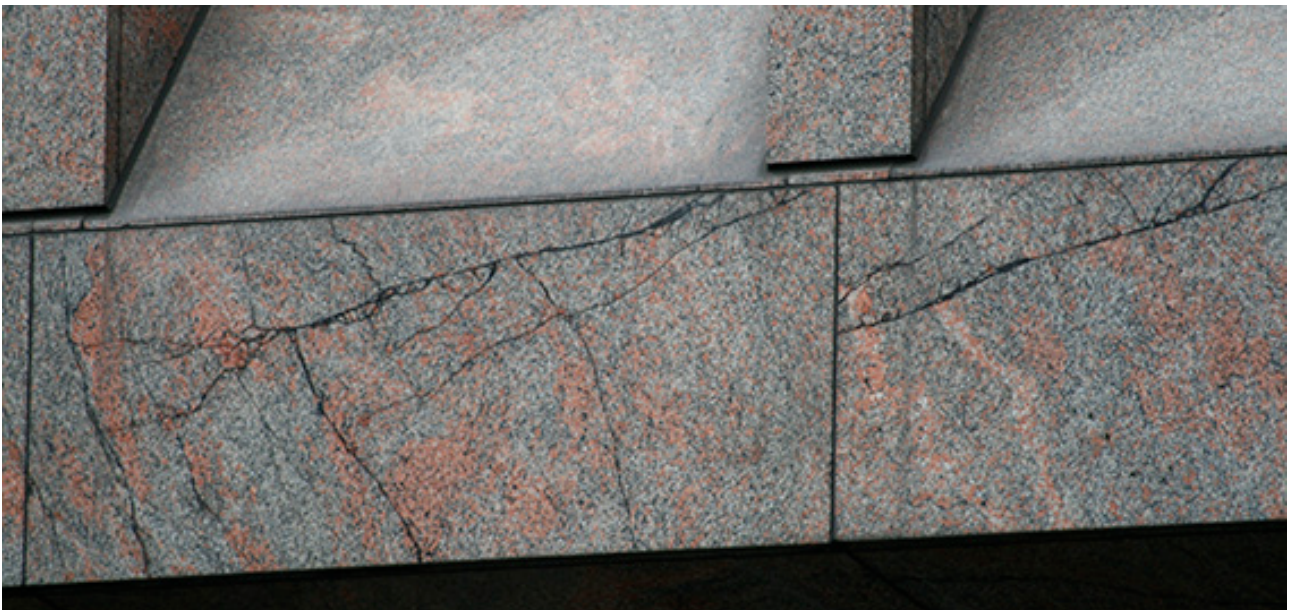


Left; satellite image of the Vredefort Dome; the course of the Vaal River is clear and Parys is marked. Right; geological map of the Vredefort-Parrys region showing metamorphic isograds delineating the impact feature (modified from Fagereng et al., 2008).

The Parys Gneiss belongs to the geological unit known as the Outer Granite Gneiss (OGG, Hart et al., 1991; Fagereng et al., 2008). The innermost zone of the core is called the Inlandsee Leucogranofels unit (ILG). A shear zone, called the 'Transition Zone' exists between the OGG and the ILG and it is here where impact-related melts, pseudotachylites, are most abundant and spectacularly developed, and the Parys Gneiss quarries lie just on the OGG side of this zone.

The Vredefort Dome is considered to be the type area for rapidly cooled impact melts, pseudotachylites (Kamo et al, 1996), and these lithologies were first identified and described here in the Vaal River by Shand (1916). A tachylite is a black, volcanic glass associated with basalt melts; a basaltic variety of obsidian. A pseudotachylite is a black, glassy rock that has not formed in a volcanic environment, literally a 'false tachylite'. The main environment of formation of these rocks is in association with meteorite impacts and, in very small volumes, pseudotachylites are formed in some fault zones. The Vredefort pseudotachylites are particularly well developed and include veins and veinlets penetrating and promulgating fractures and also supporting breccias and conglomerates. These are spectacular in outcrop and photographs can be seen in Thomas (2013). The volume of pseudotachylites encountered here are the greatest known on Earth. Only in the Sudbury impact of Ontario, Canada are similar lithologies encountered. However though clearly formed as a direct result of the impact, the precise mechanism of the formation of the pseudotachylites is poorly understood. There is neither enough evidence to associate them directly with movement along faults as friction-melts, nor is shock-melting as straightforward a mechanism for production as it would seem. However friction-melting, associated with the extremely rapid movement of faults, with the melts then extruded away from the fault zones has been considered the main mechanism for generating such volumes of pseudotachylites (see Melosh, 2003).

The stone was quarried from Leeukop, Salvamento and Kudu Quarries, all of which are now closed, situated along the flanks of Leeukop Hill (Reimold & Gibson, 2010), 2 miles north of Parys. Here the OGG is a grey trondhjemite gneiss (quartz + plagioclase), which is intruded by the pink granitic gneiss which is used here at Irongate House. Unfortunately this stone does not sample the most spectacular pseudotachylite breccias, but it is nevertheless cut-through by veins of this material, and as such is the only opportunity to see these rocks at an outcrop scale in the UK. Unfortunately, none of the lower, accessible parts of the building feature pseudotachylite veins, but they are abundant on the upper stories. A pair of binoculars or a telephoto lens would be useful pieces of field equipment when visiting Houndsditch (below).



Parys Gneiss was also marketed as African Juperana (Juperana is a name generically given to orthogneisses used as decorative stones and derives originally from Brazil, named after Lake Juperana). The quarries on Leeukop Hill were operated from the late 1970s to the 1990s. Unfortunately use of the stone was short-

lived, but the quarries have left us with spectacular exposures of the Vredefort pseudotachylites for those lucky enough to visit Southern Africa but has also left us London's Irongate House. For those able to travel further Reimold & Gibson, 2010, provide a field guide) to the Vredefort Dome.



However, buildings don't last very long in the rapidly evolving cityscapes of places such as the City of London. Irongate House is now almost 40 years old and therefore in the eyes of developers, it is reaching the end of its life. It is also a rather unprepossessing building so it may not be around for much longer. However its demolition would be a huge loss to Britain's urban geology. Do go and see it!

Irongate House is located very close to Aldgate tube station or alternatively is a short walk along Houndsditch from London's Liverpool Street.



Above; Parys Gneiss with pseudotachylite veins on Irongate House. Note the smaller fractures orientated at right angles to the main fracture at the top. Such structures form in the process of forceful injection of fluids.

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