Too hot NOT to handle: Time for a reappraisal of geothermal energy in the UK?

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Not quite Hawaii but …

There's an old Gaelic proverb which runs:
Is suarach uisge teth a' suireach fo chloich fhuar
ie "It's daft to look for hot water beneath a cold stone"

This might strike most people as common sense. But ask any ex-miner, they'll tell you that the deeper you go, the warmer it gets: there is indeed hot water to be found beneath cold stones! The natural increase in temperature with depth is called the "geothermal gradient". While it's spectacularly high in volcanic districts and in certain active earthquake zones (frictional heat takes a long time to dissipate) it's still significant in geologically calm areas such as the UK. Even in the coolest parts of the Earth's crust in the UK, we'd still expect a 1°C rise for every 50m depth. Much steeper geothermal gradients are found in places underlain by certain types of granite, which spontaneously produce heat by natural (and largely harmless) radioactive decay: in such areas, a 1°C rise might occur every 25m, or occasionally in only 15m. With such a steep geothermal gradient, boreholes drilled to depths which the oil industry would find trivial (eg ~ 2 km) have the potential to encounter very hot water: so hot it could not only be used for space heating, but also to drive electrical power generators.

Heard it all before?

It has long been realised that these so-called "radiothermal granites" in the UK might well host significant geothermal resources. Experiments were undertaken in the 1970s, with only limited success, at a time when the key concerns of the Government were electricity prices and security of supply: carbon emissions were not yet on the radar screen. Now that we know that as much as 30% of CO_2 emissions are derived from gas boilers in domestic, public and commercial premises, it behoves us to re-evaluate our geothermal resources with possible space heating applications in mind. The very positive experience of the Southampton Geothermal Heating Company over the last two decades, which has successfully exploited some 1.7MW of thermal waters from a sedimentary basin, underlines this point. Furthermore, the earlier studies assumed granite to be essentially impermeable, and test boreholes were accordingly drilled far from known faults and mineral veins. A recent re-evaluation of the chemistry of mine waters encountered in the late 1980s in fluorspar workings in the North Pennines suggested that regional-scale fractures might in fact be transmitting brines from deep within the granite: something they could only do if they were permeable. The case for a scientific re-appraisal was also becoming unassailable.

Warm water from almost 1,000m underground gushes up the borehole at a rate of 400 litres per minute into a tank, during geothermal exploration.

Unlocking potential: the Eastgate experience

Thus it was that the UK's first deep geothermal exploration borehole in 20 years came to be drilled in late 2004, and further tested in 2006. As part of a major redevelopment project on the site of a former cement works in rural County Durham, the Wear Valley Task Force obtained funding from the Regional Development Agency (One NorthEast) to sink a borehole to almost 1000m, cutting more than 720m of the Weardale Granite – one of the promising "radiothermal granites" of the UK, which is nowhere exposed at surface and which had hitherto been entered by only one previous borehole. A technical team was formed comprising scientists and engineers from Newcastle University and leading consultants PB Power. In designing this borehole, we deliberately targeted a major fracture system associated with an ancient hydrothermal structure, the "Slitt Vein". The outcome was striking: not only did we find a very high geothermal gradient (almost twice as high as the national average) but we also proved the highest values of permeability ever found in granite anywhere in the world. The evidence suggests that a sufficient abundance of water hot enough to drive electrical power generation could be tapped by drilling further. In the mean time, plans are already well advanced to exploit the abundant warm water at this site forthwith for space heating and use in an indoor spa development. The "hot rocks project", as locals have dubbed it, has become the flagship for the entire redevelopment, which promises a wealth of new, sustainable economic activity where once the CO_2-emitting stacks of the cement works stood.

Science City: transforming tomorrow

The Eastgate project exemplifies how unexpected economic benefits can arise from cross-fertilisation between scientists, local government, RDAs and the private sector. This is precisely the type of outcome envisaged in the "Science Cities" initiative announced by the Chancellor of the Exchequer in 2004. Building swiftly on the Eastgate experience, a diverse portfolio of activities related to energy and the environment is now being actively developed within the Newcastle Science City initiative. "Clean Energy from the Geosphere" is one major strand; energy biosciences, fuel cells, photovoltaics of tomorrow and carbon neutral culture are others. This rich portfolio has drawn together the expertise and resources of the Universities of Newcastle, Durham and Northumbria, together with those of the New and Renewable Energy Centre (NaREC) in Northumberland, and the Centre for Process Innovation (CPI) in the Tees Valley. A robust and lively North East low-carbon energy cluster is the result, collaborating enthusiastically and bidding confidently to play a major role in emerging national initiatives such as the Energy Technologies Institute.

Clean energy from the geosphere: more than just granite

The radiothermal granites of the UK are widespread: Cornwall, Devon, the North Pennines, the Lake District, the Cairngorms, Aberdeenshire and the Mountains of Mourne. But what if you live outside these areas? Despair not: geothermal heat pump technology (GHP) offers the benefits of low-carbon heating and cooling in almost any location, simply by harvesting solar heat which is stored in the shallow subsurface. The demand for GHP is rocketing, but so fast that existing companies cannot keep up with demand. The skills a GHP fitter needs lie in mechanical, electrical and geological engineering: these are the very skills now lying dormant in the former mining areas of the UK, such as Easington District in Co Durham, which is one of the UK's worst "worklessness" blackspots. Easington District Council and Newcastle University are jointly championing an initiative within Newcastle Science City to establish the "GREAT Institute" (Geothermal Research Education and Training) to redeploy dormant skills in the service of this sunrise industry nationally, to the benefit of the local employment market. Looking still further ahead, Science City is also exploring the possibility of coupling carbon capture and storage to underground coal gasification, and deploying new biotechnologies for extracting clean energy from heavy oils and otherwise unusable high-sulphur coals.

Drilling the borehole into the Weardale granite in County Durham

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