A geological survey in transition

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Chapter 20 A geological survey in transition

Viewed from the end of the twentieth century, the period back to 1980 looks very much like one of transition, in which the BGS moved from being a traditional geological survey towards something quite different. The generally accepted mission of a national geological survey is to acquire, interpret, manage and disseminate geoscience information and knowledge on a nationwide basis for the benefit of all in society. What has changed significantly for the BGS over the last twenty years is the balance between these four different functions. The 1999 BGS Strategic Plan suggested that, in the future, less effort would be spent on the acquisition of new data and more put to the management, utilisation and dissemination of existing data and knowledge among the user community. It is the passage of the BGS from being a geological survey, whose primary concern was the traditional one of carrying out geoscience surveys to one more concerned with knowledge management and dissemination that defines this period as one of transition.

The remit of a geological survey was something that was taken up at a meeting of the directors of many of the world’s geological surveys organised in 1992 by the Geological Survey of Canada to celebrate its 150th anniversary. In a talk given at the meeting, entitled *National Geological Surveys: Their Present and Future Role*, Professor Raymond Price stated that, ‘To govern, governments require information’. Essentially, he saw geological surveys as being agencies that operate for and on behalf of Government. He described their purpose as to provide geoscience information for the development of sound public policies on mineral and energy resources, the management and mitigation of risk from natural hazards and the protection of the environment, both nationally and globally. In his analysis geological surveys do this by carrying out systematic geological, geochemical and geophysical mapping and appropriate research and by combining their findings with information taken from industrial and academic sources to create a national geoscience knowledge base. Geoscience information and expertise are provided to the public at low added cost. This is a description of the function of a geological survey that would apply in most parts of the world now, but has applied decreasingly in Great Britain since 1967.

The work programme in geological surveys has always been driven by national economic imperatives and in most countries these are most commonly allied to mineral-resource exploration and exploitation. Until the 1960s, Great Britain was no exception. The geological mapping programme was actually started by De la Beche in 1832 in Devon to provide maps for this purpose, most notably, in that area, for the copper and tin miners. Subsequently, the coalfields were subjected to more detailed surveys and resurveys than any other part of the country. The gradual decline through the nineteenth century and eventual disappearance in the late twentieth century from the UK of metalliferous mining, followed by the replacement of coal by oil and gas as the main sources of energy, are two contributors to the change in the emphasis in the UK mining economy during the twentieth century. Another was the rapid development of the service industry at the expense of manufacturing, especially in the last quarter of the twentieth century. This created a large demand for industrial and construction minerals.

In response to these changes in the external economy, the balance within the BGS research programme has changed. Research carried out on metallogenesis is now minimal, and mostly in support of overseas projects. Expertise in coalfield geology has dwindled, while support for the industrial and construction minerals extraction industry is almost entirely provided through the published 1:10 000 geological maps. The majority of the work done by the BGS in support of mineral exploration now is in relation to offshore oil and gas. Although this is significant in volume, the total research related to mineral resources is much reduced compared with previous times.

Coincident with the reduction in the demand for the Geological Survey to provide information in support of mineral-resource supply there has been an increase in the requirement to supply geoscience data for town planning, new development and environmental purposes. The beginnings of this change became evident in the 1960s, when the Survey was requested to carry out surveys of several areas that had been designated for new town development. Among them, the sites for such as Milton Keynes, Peterborough New Town and Telford were geologically surveyed on contract to the new town development agencies. Another major investigation carried out in that period was for a potential new airport for London at Maplin Sands. By the early 1980s the BGS was involved in a major, long-running programme commissioned by the Department of the Environment to produce environmental geology maps of urban Britain to be used by town planners. Geoscience information about mineral resources in this programme was then, and remains, more likely to be required for planning purposes and to control exploitation than to be used to encourage mining.

This change in emphasis within the work programme of the Survey away from support for resource exploration and exploitation took place fairly rapidly. The fact that there was significant work for the Survey to replace it in support of environmental research is due to reasons associated with the way in which urbanisation and industrialisation had taken place in Great Britain. Because the country is small and compact, most major towns grew up on or adjacent to exploitable and exploited mineral deposits, the principal ones being on the coalfields. The legacy of environmental damage in these areas is immense and provides a wide range of hazards to health and physical wellbeing of the towns' inhabitants. If these towns are to be further developed or redeveloped now that mining is almost finished and the smokestack industries are dead, the environmental damage has to be tackled to make them safe. The alternative, of re-siting the towns in pristine sites is inconceivable.

The environmental impacts on British towns, both of the growth of industrialisation and its decline, are many and diverse. There has been a change in the utilisation of water, for example. Whereas, in the past, many industrial companies used water from their own wells, the present-day, reduced demand for industrial water is more commonly met from the mains supply. Thus, the water table is rising in many ex-industrial areas. This, added to the rise in water table due to the cessation of pumping in abandoned coalfields and the increased demand for domestic water supply in areas of the country where groundwater is the main source, has changed the national groundwater regime in ways that are not yet understood. Many of the redundant industrial sites in British towns, such as gasworks and chemical plant, are contaminated with elements and organic substances known to present a health hazard to humans if ingested. Many towns are seriously undermined, having extensive networks of shallow underground cavities, many of which are unmapped. Opencast mines and quarries have been filled with unspecified types of waste, and then built over. Mine tips, which sometimes contain potentially harmful substances, have been flattened and the debris spread about during redevelopment. In many towns, urban and suburban expansion in recent decades has lead to properties being erected on ground that is liable to flooding and subsidence. Inevitably, therefore, these combine to create a powerful, new economic driver for the BGS and promise to have a major impact on the way the work programme will be structured in the future.

The Geological Survey itself, however, with a history spanning more than one hundred and sixty years, has also matured. Professor Price pointed out, in his address to survey directors in Ottawa, that systematic mapping is at the core of a geological survey's work programme. The question he did not address was what happens when the systematic surveys are complete? Experience in Great Britain suggests that there are four stages through which geological (geochemical and geophysical) mapping pass. They are not necessarily sequential in the sense that one must finish before the next can start, but their start dates will normally be sequential.

The first is a reconnaissance stage. During it, rapid surveys are carried out in all parts of the country, essentially just to see what is there. In Great Britain, this was mostly done by gentlemen amateurs and engineers, such as William Smith, before the Geological Survey was founded. The Geological Survey itself was established to carry out stage two: to do a systematic survey of the whole country at a single scale to common standards. The maps so produced become the primary reference source for geological information in that country. The scale chosen in Great Britain was one inch to one mile, or, nowadays, 1:50 000. In larger countries the scale may be much smaller, because it is important that the whole country is completed at the one scale. Called the Primary Survey by the BGS, this only finished when the last area in the Scottish Highlands was completed in the 1990s.

Stage three is to carry out detailed mapping at a larger scale than the primary survey, on a systematic basis. Again, the objective is to map at a common scale and standard, but this activity tends to be demand driven and it is unlikely that the whole of any country would be covered in this stage. In Britain the scale of six inches to the mile, or 1:10 000, was chosen for the geological survey, and it is probably justifiable economically to map no more than about 80% of the country at this scale. Again, it is a systematic survey, providing information with many potential uses and no specific clients.

The fact that stage-three surveys are usually demand driven means that in the absence of demand they may never take place, no matter how desirable geoscientists think it is to do them. Usually it is the outside community of users which determines demand. For example, it was the Government, acting on behalf of the coal industry, which instructed the Geological Survey to carry out the detailed surveys of the coalfields in 1871 and 1919. In the post-nationalisation period, after the second world war, the National Coal Board asked for improved maps. Resources were made available and the surveys were carried out. In some cases, the Survey staff themselves may have sufficient experience to know that certain systematic surveys, if carried out, will provide great benefits. Demonstrating the case, however, may be very difficult and where there are financial constraints such surveys may never acquire sufficiently high priority to be funded.

The fourth stage is one in which the main purpose is to revise, improve, update and enrich the databases created during the systematic surveys of stages one to three. There are two parts to this stage. In one, the existing databases are improved by collecting data at the same level of resolution as the systematic survey. Programmes of systematic map revision or opportunistic data collection may do this. For example, in the fifteen-year geological mapping programme that began in 1990 many areas previously mapped at the scale of six inches to the mile or 1:10 000 during stage three were resurveyed in order to modernise and improve the map. Independently of this type of revision exercise, geological field staff have, in the past, opportunistically visited new road cuttings and excavations for the foundations for new buildings to collect information that will improve an existing, good-quality map. Both types of activity are necessary if the geological map database is not to devalue and degrade with time. Opinion in the 1980s was that major map revision should be conducted at least every fifty years or, in urban areas and coalfields, every twenty-five years. It is now possible, if the geological map information for the whole country is held in digital form, to do this differently. New information, whether it is acquired from a systematic revision resurvey or opportunistically, will be used to improve the digital database. Instead of reprinting published geological maps that have been revised, which has been the practice until now, updated versions of them can be generated from the improved digital database and plotted electrostatically on demand.

For geochemical and geophysical surveys revision has been done digitally for some time.

The other part to stage four is client-centred surveying, targeted for specific purposes. This means that the mapping parameters chosen, including scale, may vary from area to area. Examples of this sort of activity include the preparation of thematic maps for land-use planners, where engineering geology properties, man-made ground and geological hazards are represented on maps. Another example is fracture mapping such as that done for UK Nirex Ltd in the Lake District. This was done in great detail at a very large scale in selected surface outcrops in order to contribute to a project designed to gain understanding of the fracture systems in the rocks and their impact on the hydrogeological regime in a repository for radioactive waste at depth. Generally, there must already exist good, large-scale geological maps for the targeted area. Additional fieldwork is usually required, but for the purpose of collecting the data specifically required for the defined end purpose. This sort of activity enriches rather than improves the databases created during the systematic surveys.

The nature of the research carried out in association with each of the four stages is also different. During the first three stages, research is mostly required to enhance the quality of the systematic surveys by, for example, improving the understanding of the stratigraphy or the geochemical and geophysical parameters being measured. Research of this type is also required in stage four to accompany the revision of the databases, but most of the research in stage four will be driven primarily by client needs and may not necessarily make any contribution to the improvement of existing maps or databases.

The BGS is close to completing systematic surveys in all disciplines. The gravity and low-resolution, aeromagnetic primary (stage two) surveys are both complete. A high-resolution, effectively stage-three, aeromagnetic and radiometric survey has begun, with flights over the East Midlands, but the extent to which this stage should be continued is still being debated. Three major, strategic mapping programmes are nearly complete. One is the Geological Mapping Programme, which as structured at present is a combination of: completion of the primary survey (stage two); completion of stage three and a revision of some earlier stage-three surveys; and stage-four activity. The second is the Regional Geochemical Survey, a primary survey. Both of these systematic surveys should be completed by 2010. In the third, the Primary Offshore Survey is complete except for western waters and the near-shore zone. The former is progressing with the help of co-funding from the oil-exploration industry. Completion of the near-shore zone is not in prospect — a case of a primary survey that has never been able to climb high enough in any list of priorities to be funded.

There are few examples of any kind of systematic survey that can be considered as essential, other than those either still in hand or completed. One for which an argument can be made is a national systematic survey of physical properties of all rock types, which is needed to make best use of the national gravity and aeromagnetic databases and to support geotechnical, geohazard and resource studies. Even if the case for this is accepted and funding could be found to carry it out, it would not affect the general statement that the BGS is very close to the end of the era in which nationwide, systematic surveys are of central importance in its work programme, and it stands on the threshold of a future in which stage-four types of activity will predominate.

The diminution of the importance of mineral-resource-related research and the ending of the dominance of the systematic surveys are evolutionary changes that all geological surveys are likely to experience as the society and national economy within which they exist also change. There are two other important factors that have driven change within the BGS during this transitional period, however, which have combined, possibly in a unique way, because of the national political setting within Great Britain after 1979. These are in the way in which the Survey interacts with the community that uses geoscientific information and the impact of computing technology on the way the Survey works.

Consider first the interaction with the users of geoscientific information. This began to change as a result of Rothschild. Before Rothschild, the corporate mindset within the BGS was dictated by the primacy of the systematic survey within the work programme. Being multipurpose and having no single customer, even though there was a single funding agency for the systematic surveys, there was no obvious need for dialogue with any outside agency or customer about how it should be conducted. If changes were to be made as a result of outside influence, they would usually be in relation to the order in which areas were mapped, not how or whether they should be done.

After Rothschild, Government departments to which funds had been transferred, found that either they had become customers who required the research and survey results to support their own policy initiatives or they were acting as surrogates for a huge range of beneficiaries among the general public. They began to specify their own sectorial, geoscientific needs, the effect of which on the BGS was to make the organisation conscious first that customers existed and next that they had needs. As the Commissioned Research Programme grew, reducing the dominance of the systematic surveys, this consciousness spread. The creation of the Programme Board, which acted as a surrogate customer for the Core Programme, brought awareness of customer needs even for the strategic, systematic surveys.

Initiatives taken by Government after 1979 forced other changes in the BGS culture. One was the pressure on them to adjust to requirements of the market economy and change many of their practices. When the Rayner review in the early 1980s led eventually to all departments putting their research contracts to competitive tender, the BGS had to respond by espousing some of the culture of the private sector to give it the flexibility needed to win contracts in this new environment.

Interaction between the BGS and the user community has always been on two levels. At the highest level it was with surrogate customers, largely through the strategic survey programmes. At the level below, there was the direct link between the BGS and the eventual end user of the information. This may have been via a commissioned research project or the sale of a map or the answer provided to an enquiry. This lower level originally took up a smaller portion of the work effort than the other, but from the early 1980s the relative proportion and nature of work done in it was set to change. At this time, the BGS began to acquire more and more commissioned research contracts that directly met tightly specified customer needs. Initially they were with Government departments, but later the amount of contract work with the private sector, such as for UK Nirex Ltd, grew. Competition for these contracts could be fierce, and the BGS often found it was expedient either to form a partnership with private-sector consultancies or to become a subcontractor to them. It also became necessary for the BGS to hire specialists from the private sector to cover skill shortages when competing for some contracts. Gradually, Survey staff became adept at tendering and not afraid to use some of the devices which were commonly practiced in the private sector to win contracts but which were not strictly within what was still perceived to be the spirit of a public service. The end result was to establish the BGS as a hybrid organisation: a public-service body that does commercial work: not a business, but businesslike in its behaviour.

The provision of information directly to a customer, by means of a published product or a written answer to an enquiry, has always been an essential, though minor, aspect of the Survey's interaction with the general public. There has never been any question that the BGS should not publish and sell the maps, memoirs and other books that had always been its standard outputs, but once the Survey began to be commercialised, ideas for new products to publish and computer systems to deliver information to enquirers began to be generated. The question was posed: how far down the production chain should the BGS go as a public-service body? Should it confine itself to providing data for third parties to add value to and sell on, or should it develop value-added products itself and sell them directly. The option of providing the data free for everyone, which is the practice in some countries that are barred by law or Government regulation from undertaking the sort of activities common in the BGS, disappeared from consideration after the 1979 general election. A second, but equally important question was whether or not the BGS should serve the mass market.

When posed as questions for debate among senior managers there was never a unanimous answer. When looked at in relation to the sort of response the Survey should make to changes in its circumstances being forced on it from the outside the answers were quite clear.

Income from almost all commissioned research projects only covered costs. The pressure from Government for the BGS to make a contribution to its core funding from commissioned earnings, especially after the report of the Charging Review, meant that ways had to be found to generate a surplus over average operational costs. The most obvious way was to sell products or services on which it was legitimate to add a mark-up. In other words, the Survey should go as far down the value chain as possible and the larger the market that could be addressed, the bigger the potential return. This was despite the fact that the skills needed to do this, such as in product design and development, conversion of a prototype to a production model, systems management, marketing and selling, lay outside the Survey's core competence. Price Waterhouse had dealt with the question about the mass market when it recommended that the BGS should concentrate on the high-quality, high-price end of the market spectrum. This might have been the correct decision at the time. It took into account the emphasis on systematic surveys in the work programme, the Survey's core competences and aspirations for itself and the known technological limits in 1990, but it was a decision that technology was going quickly to make redundant.

Even before Price Waterhouse, attempts had been made to develop value-added products to meet the needs of niche markets and generate an operational surplus. In the late 1980s the so-called Enterprise projects were funded with this purpose in mind. Extremely successful in the mid-1990s were the geophysical atlases developed for the offshore oil-exploration industry. The most successful of the early attempts, though, was the development of the Geohazard Susceptibility Package (GHASP) for sale to insurance companies. Using data taken from geological maps, an algorithm was devised that produced a score to give an indication of the potential for damage to property from subsidence in any post-code district. The development of GHASP was a major breakthrough for the BGS. It was the first time the Survey had tried to address the needs of a part of the community that did not traditionally regard geoscience as relevant. With the success of GHASP, staff began to devise ideas for tackling other markets. Examples included information on ground conditions for conveyancers, property owners and estate agents; radon information for the general public; geological synopses for civil engineers, mini-maps for big landowners and the provision of site-specific geochemical data to deal with contaminated land problems. In parallel, a system had been developed by the Global Seismology Group to provide information on the potential for earthquakes in large industrial sites.

In all of these, the BGS would deal directly with the customer. None of the products could be devised without consultation with end users. This was quite different from being aware of customer needs and being able to react to them. It was something about which the Survey had to be proactive. Potential customers had to be sought and their needs taken into account in the process of devising and designing the new products to suit market needs. In this respect there was little difference between the way in which the BGS had now to operate and the average private-sector firm.

The revolution in computing that has taken place during this period of transition has been pervasive in its impact on the way that the Survey worked, but it has had a very special impact in relation to the Survey's ambitions for the development of value-added products. This is well exemplified by GHASP. GHASP was a value-added product, the operation of which depended entirely on IT and the availability of digital data to feed the system. Writing the software was relatively easy, but the general absence of appropriate geological data in digital form created a serious problem. All the other ideas staff had for similar types of value-added products for the general public were also IT based and required basic geological information to be in digital form.

GHASP was delivered to customers on a floppy disk or CD-ROM, but later ideas required the generation of large numbers of individually customised products determined by variable parameters on demand. To do this required a fairly complicated computer system to interrogate databases, analyse the data and deliver a simple, readable report. The development of the ALGI system (Addresslinked Geological Inventory), which provided site-specific geological information suitable for house purchasers and conveyancers to use, was salutary in demonstrating the problems associated with the development of such IT systems and the size of the data-conversion task (analogue to digital) to support it. It provided the momentum behind moves to organise and digitise the Survey’s data holdings, including all the 1:50 000-scale geological maps, and establish cross-BGS standards in database management.

With regard to the method of transmitting the information contained in these value-added products to customers directly, the Geomagnetism Group had demonstrated as early as 1994 how to do it using the Internet. When the Government changed in 1997 and New Labour showed enthusiasm for developing the ‘knowledge economy’ and exploiting the Internet to achieve mass communication, the BGS found another justification for the moving in this direction for delivering data and value-added products to its customers.

Once the potential of the Internet came to be appreciated, the traditional methods of disseminating information, such as selling maps, answering enquiries from the general public and carrying out minor project work and research on repayment, which the BGS had always done, had to be reappraised. As they stood, these services, including the way that access to the Survey’s databases was gained, were available only to the knowledgeable and, in some cases, the rich. Modern communications technology now potentially gave everyone that same opportunity. The general public now knows that the Internet allows anyone, anywhere in the world, to have direct access to centres of knowledge and expertise wherever they are, and expects those centres to have their data, information and knowledge available to them. Geological surveys are unique within their nations in their holdings of geoscientific data and have to face up to the reality of organising themselves to meet the public’s expectations of them as very specialised centres of expertise. In other words, it is now unavoidable for geological surveys to consider finding ways to communicate with a mass market using the Internet or its successors. This includes developing value-added products that are suitable for delivery via the Internet and understandable by people with no specialist knowledge in geoscience.

The effect of this and all the other changes that have taken place in BGS during the last twenty years on the definition of what a geological survey is expected to do are quite considerable. In his address to the geological survey directors at the meeting in Canada in 1992 (page 195), Professor Price stressed that a geological survey worked primarily for Government and that its main function was to carry out systematic surveys. This was the way, in his view, that they fulfilled their requirement to meet the geoscientific information needs of the nation. He said that the shift away from service to government and the general public towards the sale of information and professional services in the open market would inevitably lead to the demise of the geological survey. I believe that the experience of the BGS shows and will continue to show that this is completely wrong.

The position that the BGS found itself in towards the end of the 1990s, while quite different from the one to be expected for a traditional geological survey, does not mean that the BGS is no longer a geological survey. The BGS is on the verge of becoming a mature geological survey: one in which stage-four-type activities predominate and the main national, systematic surveys will have been completed. In the future, the UK Government will not lose its need for geoscience information for policy formulation, and the Survey will have to continue with programmes of revision of its maps and databases in order to remain fit to serve Government, the general public and its commercial clients. However, the results of the UK Government policy, as well as other evolutionary changes in the Survey and society outside, are likely to lead to a large and continuing demand for geoscience information to be delivered directly to the consumer, whether it is a geoscience specialist or the general public. There is no resistance in the community within Great Britain for this to be done for a fee, which may have a small element of profit in it.

What this means is that the part of the remit for a geological survey that Professor Price describes as providing information to the general public at low added cost may become a major activity and one that is indistinguishable from the sale of information and provision of professional services. In other words, the needs of geoscience specialists and the general public for geoscience information can be met in the short term, at least, primarily by commercial means. In a mature geological survey, such as the BGS, this will come increasingly to dominate the work profile. The proportion of the total amount of information delivered this way rather than at no added cost, however, is likely to change in the future. The BGS has learned already that it is cheaper to give some types of information away on the Internet than formally to print, publish and sell it. It is conceivable that even the map-face data on the 1:50 000 geological maps, which are currently sold, could be made available for no charge over the Internet when the DigMapGB project is finished. The boundary between what can be given away and what should be sold is, at present, therefore, not fixed.

There is another gradually emerging truth. The Internet has made the debate about how far a geological survey should proceed down the value chain irrelevant. Not only does it appear to be more cost effective for a geological survey to devise its own systems to deliver information to the general public directly over the Internet, rather than via a private-sector intermediary, but such information also tends to be trusted more by the recipients when they know it comes from source. There is also growing evidence that the users feel that there is less chance of profiteering when a public-service body engages directly with customers this way.

The BGS, in common with other geological surveys of the future, will continue to build up the national geoscientific database, for which it is the natural custodian, by carrying out field studies and research, in some cases following traditional practices. It will be the requirement to continue to maintain a high-quality national database, in the era following the completion of the systematic surveys, that will determine the content and shape of the programmes of primary data acquisition. Increasingly, however, the Survey will become more concerned with basic issues of data management and communication, and it is the latter that is likely to become king. Essentially, everything that will go on in the BGS will have to be planned in order to maximise the Survey’s capability to communicate directly with the user community to meet all sorts of needs within it. Increasingly, this will be done using the Internet or its successors. The impact of all of this on the skills profile for the Survey is profound and will require it to make considerable changes. There will be a need for fewer geoscientists, more specialists in ICT (information and communications technology) and data management; fewer senior scientists and more junior staff concerned with housekeeping tasks. The sort of geological survey that the BGS will become will be quite different from the traditional model. Rather than being primarily concerned with data collection it will be firmly placed within the knowledge economy at the hub of a communication network for the dissemination of geoscience information and data. The next history to written about the Survey will show whether or not this actually happened.

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