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# Reusable tools for smartphone apps: innovative activities in the European geological sector


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## Glossary

| | |
|---|---|
| API | Application Programming Interface |
| ARE3NA | A Reusable INSPIRE Reference Platform |
| BGS | British Geological Survey |
| BRGM | *Bureau de Recherches Géologiques et Minières* |
| CEH | Centre for Ecology and Hydrology |
| GEUS | Geological Survey of Denmark and Greenland |
| GIS | Geographical Information System |
| IPR | Intellectual Property Right |
| ISA | Interoperability Solutions for European Public Administrations |
| JRC | Joint Research Centre |
| NERC | Natural Environment Research Council |
| OGC | Open Geospatial Consortium |
| SGU | Geological Survey of Sweden |
| WMS | OGC Web Map Service |

# 1 Introduction

This report presents the outcomes of a study to explore *"Reusable tools for smartphone apps: innovative activities in the European geological sector"* launched by the European Commission's Joint Research Centre (JRC) with the British Geological Survey (BGS, Contract n°389788). The study is part of A Reusable INSPIRE Reference Platform (ARE3NA), Action 1.17 of the European Union's Interoperability Solutions for European Public Administrations (ISA) Programme. The general objective of the study was to assist the JRC in exploring the developments and behind-the-scene activities that the geology sector in Europe is undertaking in terms of mobile applications (commonly known as 'apps') and where geospatial data of relevance to the INSPIRE Directive (2007/2/EC[1]) was being shared and reused.

Mobile apps are increasingly being used across Europe to provide geoscience information and solutions. To understand the extent and approach of these developments, we undertook a survey of the geology sector. The results of this survey were designed to:

- help national geological organisations and the wider geological community discover more about work being undertaken
- help organisations not yet active in this area learn and benefit from those that have already taken some first steps, helping to explore the potential reusability of solutions
- be of benefit to other sectors interested in sharing geospatial data through apps
- understand whether INSPIRE is contributing to data access via mobile apps

In order to accomplish this, we needed to discover which organisations were actively developing apps, what approaches they have taken, what tools they have used and how successful their initiatives have been. We also explore the types of users that are being reached by mobile apps and whether these tools have created new uses for geoscience spatial data, not only the delivery of data to 'traditional' organisations involved in data exchange but also where data are being provided in less conventional ways to other/new users, including citizens and those aiming to reuse the data being provided in other apps not only related to geology.

Finally, we assessed how other organisations and communities can learn from the software, tools and methodologies that have been developed in the geosciences sector.

# 2 Survey respondents

The survey was conducted online between April and July 2014, and targeted EuroGeoSurveys members. EuroGeoSurveys are a not-for-profit organisation representing 33 national and regional geological surveys across Europe, an overall workforce of several thousand experts. These organisations have a long tradition in collecting data, preparing information and conducting research focused on their national subsurface. They are also the custodians of the geological data, have responsibilities for managing the information for long-term benefits and have a remit for its dissemination.

[1] See *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:108:0001:0014:en:PDF*

In addition to the survey, we also conducted a review of the Apple App Store and Google Play Store to get a wider feel for the range of apps available and to build up as complete a picture as possible of activities in this context.

Outside of the remit of this study are the many geology apps that are available from a wide variety of non-European geological survey organisations e.g. education establishments and commercial companies.

We received responses from 18 countries across Europe (Figure 1) and they were completed by a range of professionals on behalf of their organisation: around 61% were technologists (IT manager, developer or data/informatics), around 28% were geoscientists and the remaining responses from a strategist (6%) and another responsible for communication (6%) (Figure 2). This represents a 55% response rate from EuroGe-oSurvey members covering many EU Member States. It gives a good representation of the sector and indications of the benefits of app development, as obtained from the survey.

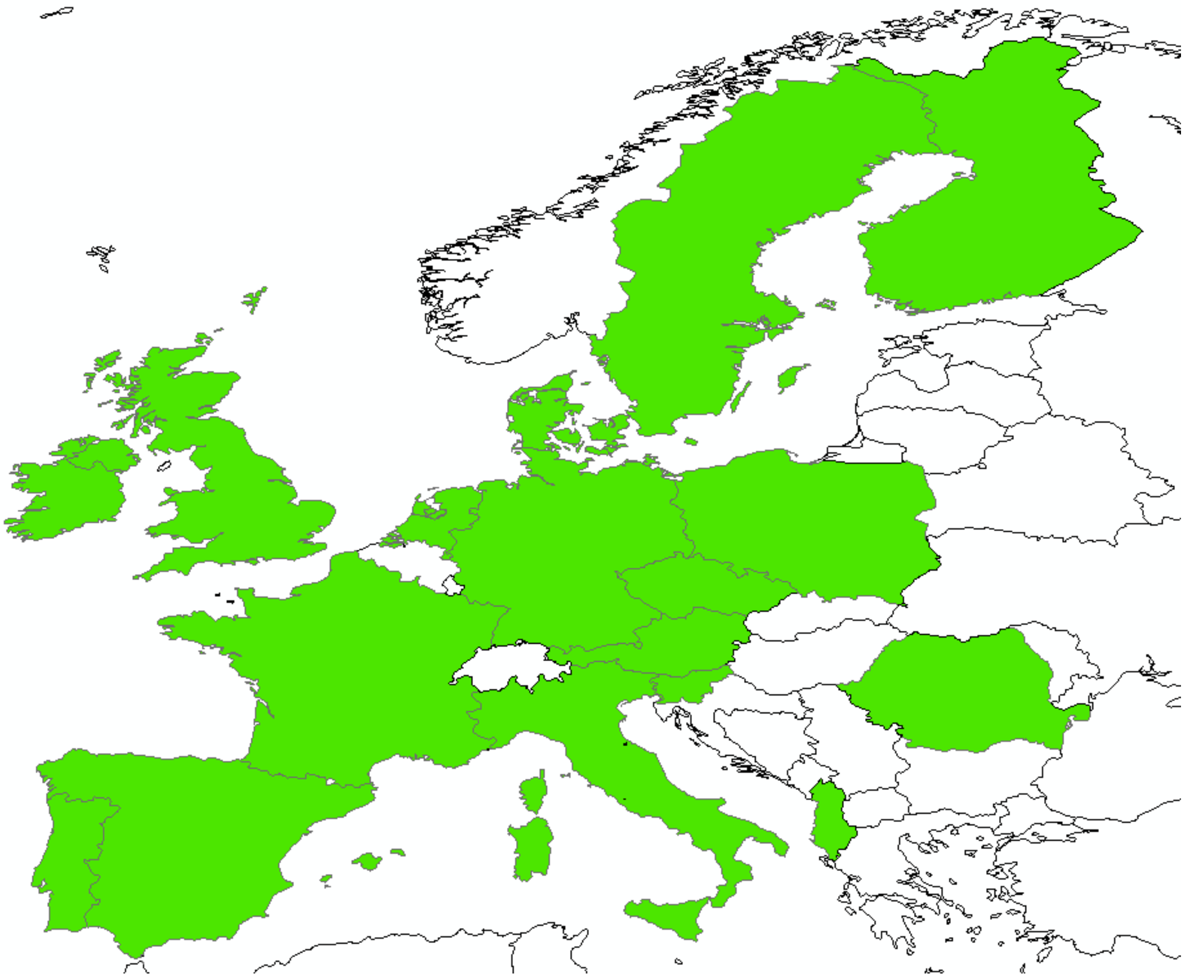

**Figure 1: Spatial distribution of survey responses across Europe**

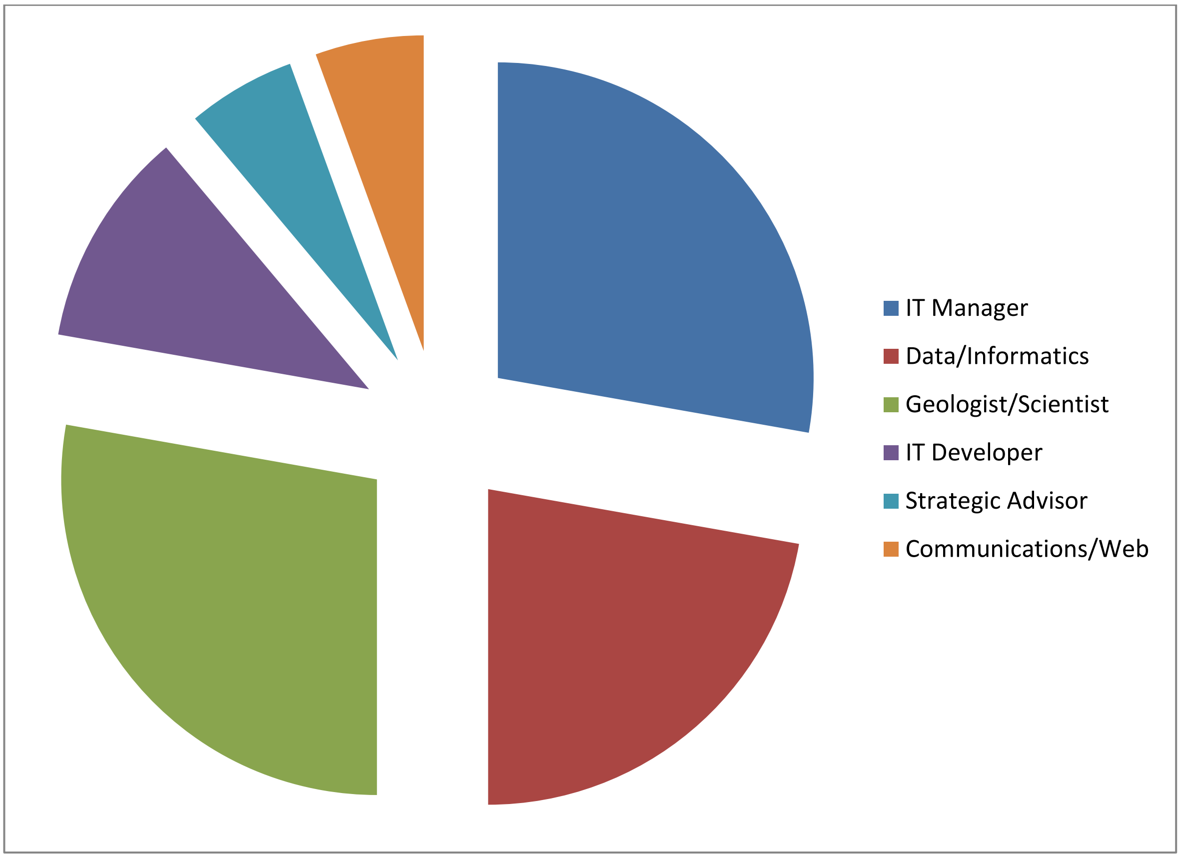


**Figure 2: Role of survey respondents within their organisation**

## 3 Existing app development

One of our key goals was to gain a better understanding of:

- The extent of app development across the geological community
- What purposes these apps are being developed
- What functionality they provided
- What apps are planned for the future
- What mobile platforms are being supported
- Which are seen as the most important platforms to support
- Whether apps are free or have charges
- How long organisations have been involved in app development
- How often these apps are updated

For those not developing apps, we also wanted to understand more about why they had not engaged in such activities and what they perceived to be the barriers to developing apps.

In total, 13 organisations replied that they were actively engaged in app development, telling us about 23 different apps. Figure 3 shows the range of purposes for which these apps are being developed from general tasks such as providing access to mapping data (37%) and a further 26% notably supporting data collection as well as thematic applications. Our review of the app stores provided a similar result.

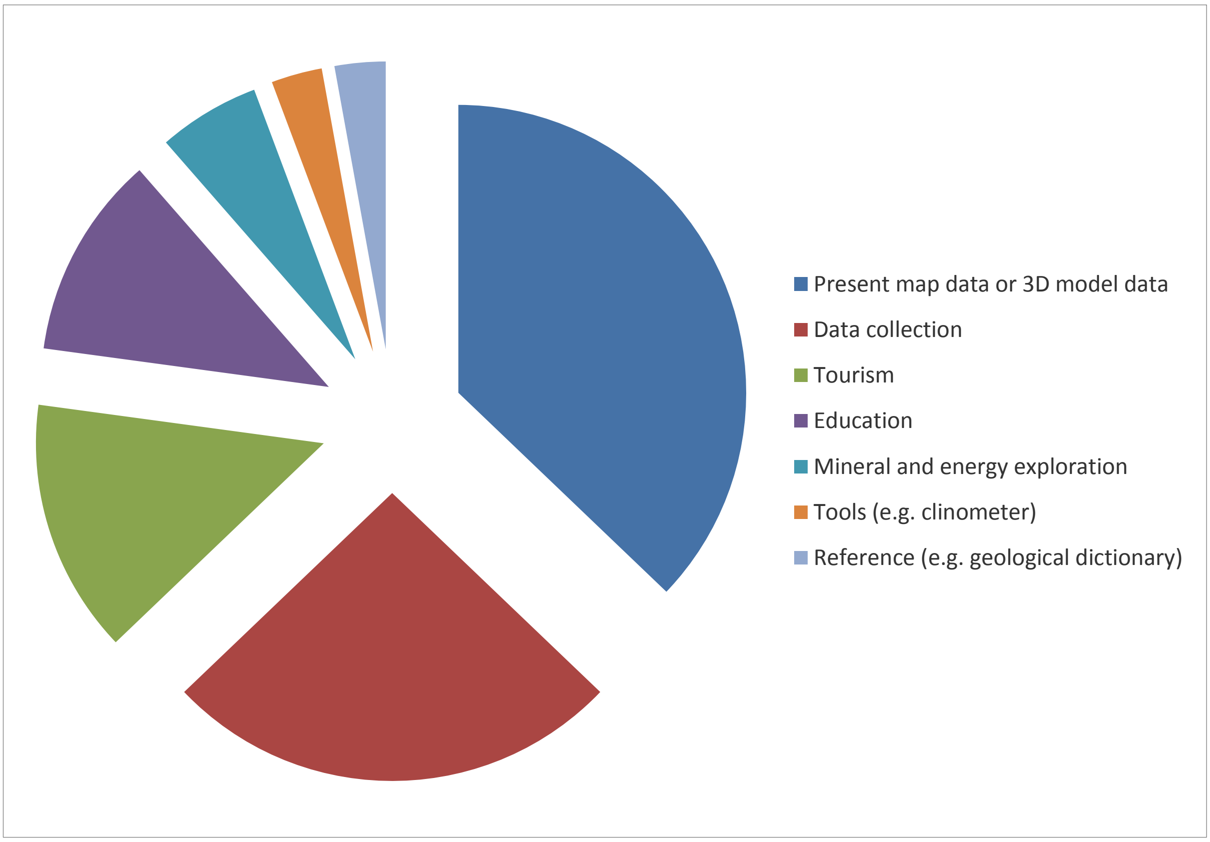


**Figure 3: Functions of developed smartphone apps**

Examples include:

- BGS's iGeology which gives access to its digital geology mapping at 1:50,000 scale for the whole of the UK (Figure 4). Appendix 1 provides a case study of the BGS approach to mobile app development which gives further details about iGeology.
- i-InfoGeol from the *Bureau de Recherches Géologiques et Minières* (BRGM) provides similar information for France (Figure 5)
- The Geological Survey of Sweden's (SGU) GeoMap (*Geokartan*) is providing the same for Sweden (Figure 6)

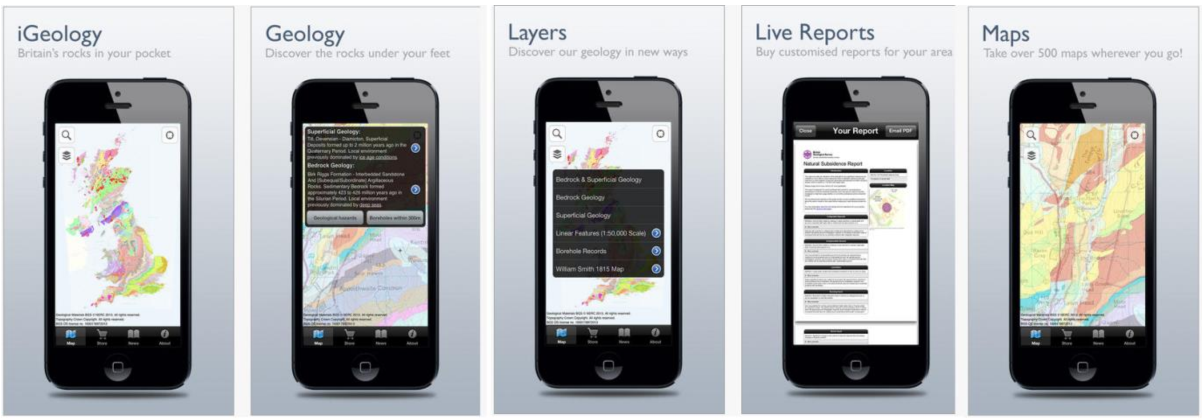


**Figure 4: Screenshots from the BGS iGeology app**


**Figure 5: Screenshots from the BRGM InfoGeol app**

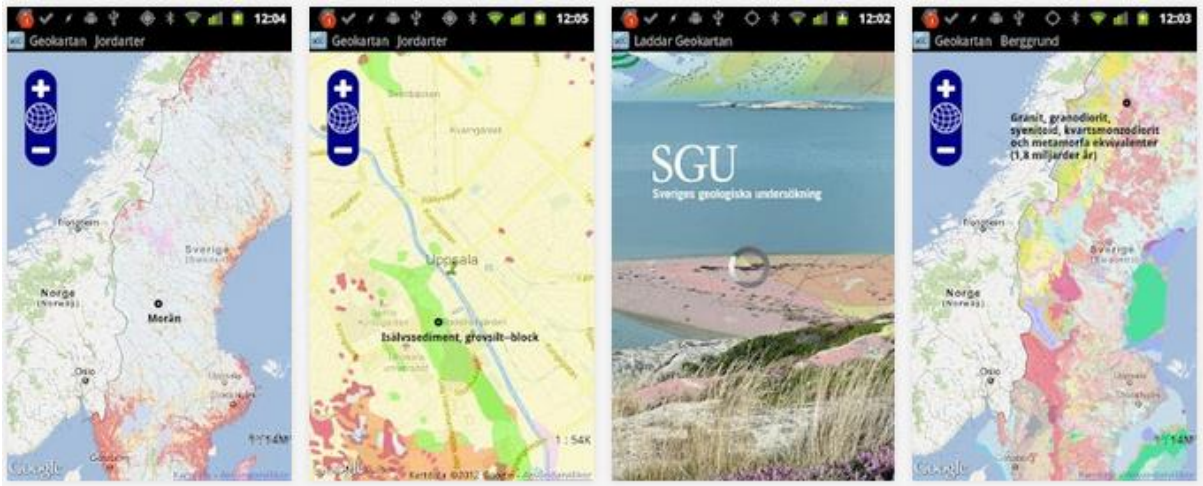


**Figure 6: Screenshots from the SGU GeoMap (*Geokartan*) app**

Data collection apps in geosciences are also popular. One example is aFieldWork (Figure 7) from the Geological Survey of Denmark and Greenland (GEUS) which provides field geologists working in harsh conditions with a quick and efficient way of recording information on a geological locality in a digital format; allowing for the data to be quickly and efficiently transferred into central databases and Geographical Information Systems (GIS).

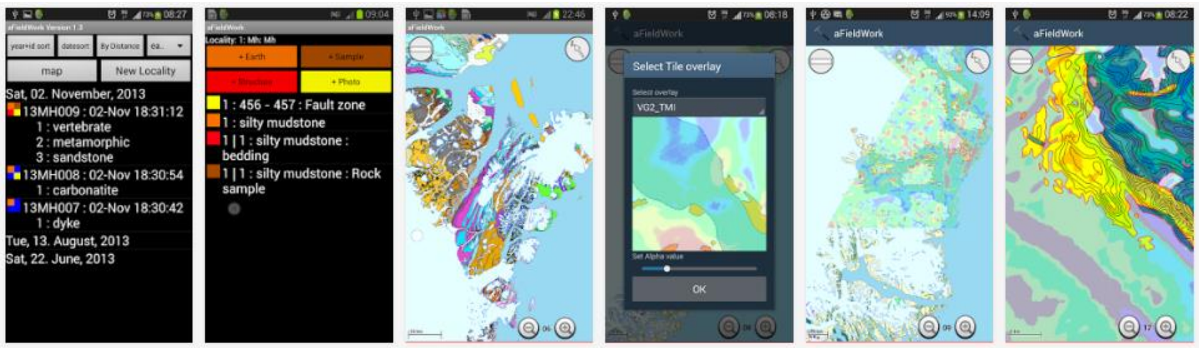


**Figure 7: Screenshots from the GEUS aFieldWork app**

Geotourism is another popular purpose. GeoTreats, for example, is an app for finding geotourism sites (Figure 8). Originally initiated by a number of Nordic geological surveys, it is now being extended to other parts of the world.

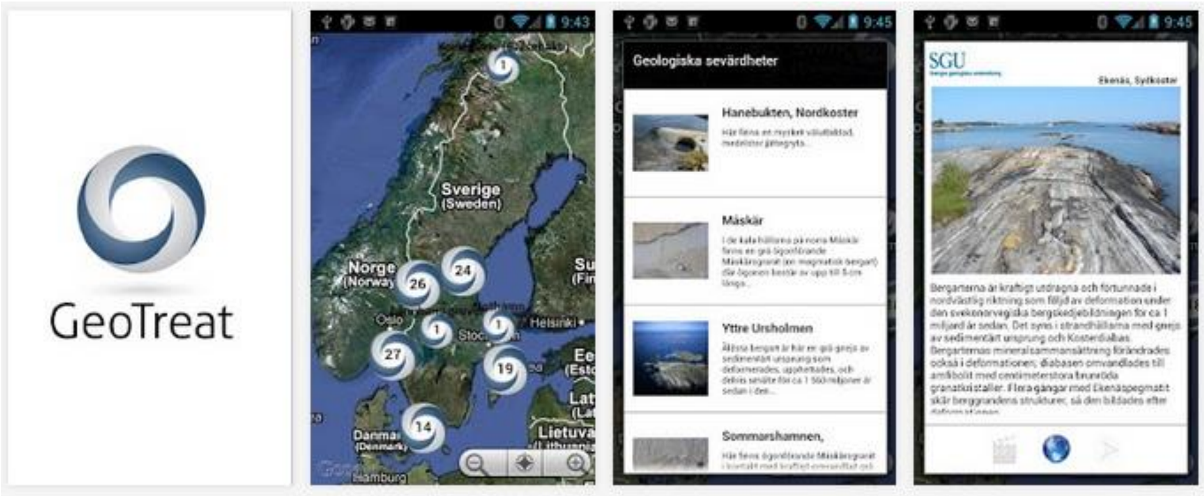


**Figure 8: Screenshots from the GeoTreat app from Nordic geological surveys**

Appendix 2 gives an inventory of released apps either declared in the survey or found in the app stores. It demonstrates a vibrant, mature app development community amongst European geological surveys. The first apps developed were released in 2010 and there has been a steady growth since then, with 4 or 5 new apps being released each year.

All apps developed by geological surveys are made available free of charge. There is one example (iGeology from the BGS) of an app that provides additional chargeable services (in app purchases) thus offering a 'freemium' approach to information delivery. We can, to some extent, see that European geological surveys understand the app market and appreciate how the technology can help them meet and advance their information delivery requirements and obligations. Apps are used to promote the work of geological surveys and to engage in collaboration and partnership-working, rather than being seen as a direct method of revenue generation.

The majority of apps focus on providing existing functionality more conveniently to users on the move. There are also examples of more innovative use of the mobile platform to provide greater functionality and more interactive information delivery. For example the BGS's iGeology 3D app uses augmented reality to bring the geology map to life (Figure 9). Highly innovative, this mobile app utilises the GPS, camera, tilt sensor, compass and motion detector functions on tablets and smartphones to paint a geology map over the landscape as you view it through your device's camera.


**Figure 9: Screenshots from the BGS iGeology 3D app**

Survey responses also indicate that many more apps are in development and that geological surveys are continuing to expand their portfolio of apps, extending the functionality they provide.

## 4 Platforms

When developing smartphone apps, strong consideration needs to be given to the platforms that are supported (Android, iOS etc). Each platform requires that apps are developed in a particular way, often in a different development language. As well as the extra development effort, there is an additional maintenance overhead for each platform supported. When considering which platforms to support, it is important to consider targeted users; where they are geographically, their demographic composition and their socio-economic status. These factors will all influence the type of device likely to be carried and, ultimately, guide the organisation on what platforms to support. In a later section, we will discuss a growing number of tools that enable multiple platforms to be reached from a single development.

The survey results indicate that Android and iOS are the only native platforms specifically being targeted for app development by the European geological surveys. These are also the platforms that the geological surveys feel are the most important ones to support (Figure 10). This mirrors information in the public domain about the most popular device types, but contradicts BGS's experience of its user base which is predominantly iOS-based.

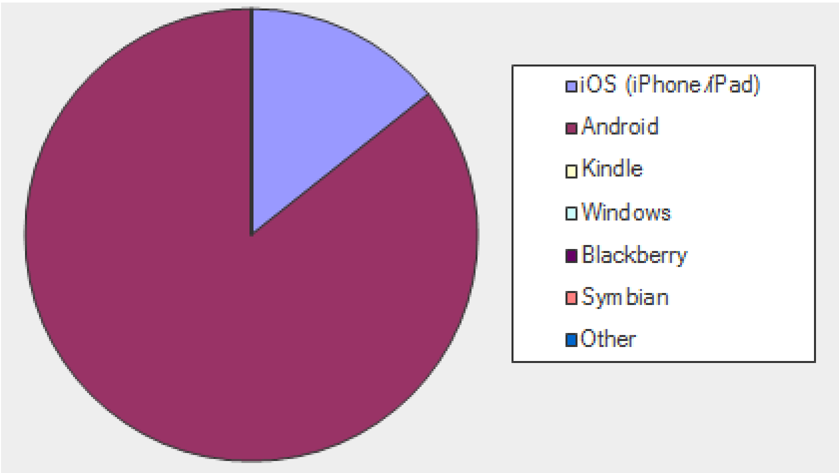


**Figure 10: Most important mobile platforms to support in the view of geological surveys**

## 5 Skills and partnership working

One of the key questions we are asking in this survey is who is doing this app development within the geological surveys, what skills exists and how shareable are the app tools for the benefit of others? Interestingly, there is an equal split between geological surveys doing in-house development/creation capabilities within their development teams and surveys contracting out the work to specialist external app development contractors. The importance of collaborative working is clear, with 60% of all apps created being produced in partnership with other organisations. These partnerships include both geological and non-geological organisations (within and between countries), demonstrating that apps can be used to focus integrated, cross-cutting information delivery systems and multi-disciplinary solutions to environmental problems.

## 6 Implementation methods

There are a number of approaches that can be taken when developing smartphone apps. However, the survey found three main approaches that are leading developments (Figure 11). These include:

- Development of native apps, individually coded for each specific platform.
- The use of cross platform frameworks that enable an app to be created once using common web Application Programming Interfaces (APIs) and then exported for deployment on a range of different mobile platforms (Figure 12).
- The development of a web app designed for browsers, thus reaching a wide range of mobile devices.

It is possible that some overlap of approaches may occur in some app development.

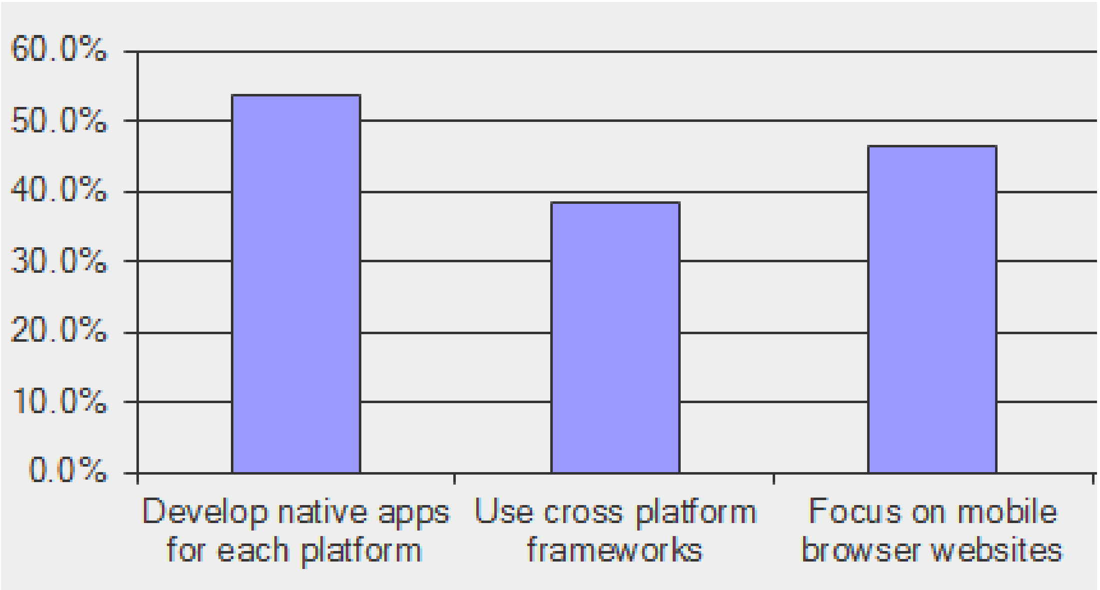


**Figure 11: Implementation methods for smartphone apps**

There are advantages and disadvantages in all methods as outlined in Figure 13. Mobile websites are far quicker and less expensive to create and cover many more platforms in a single development. They display optimally on whichever screen size they are being viewed, as well as being accessible to desktop applications. Native apps, on the other hand, have greater visibility on the individual app platforms (Apple store, Google Play etc), generally provide a better content experience, offer offline capability and enable full access to hardware available on smartphones.

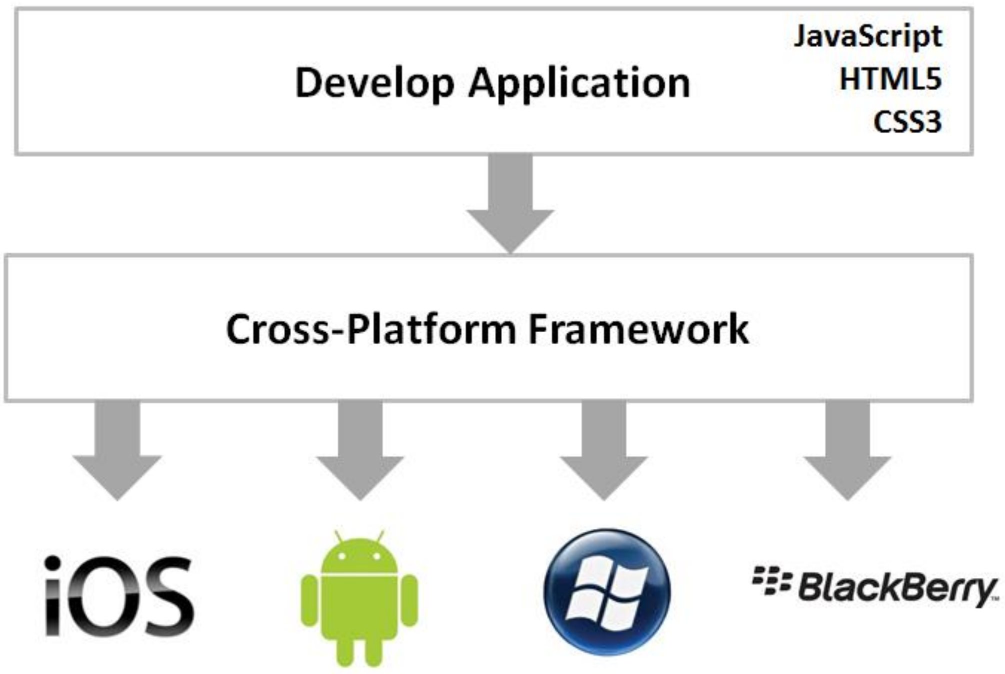


**Figure 12: Cross platform development frameworks – develop once and deploy to many platforms**

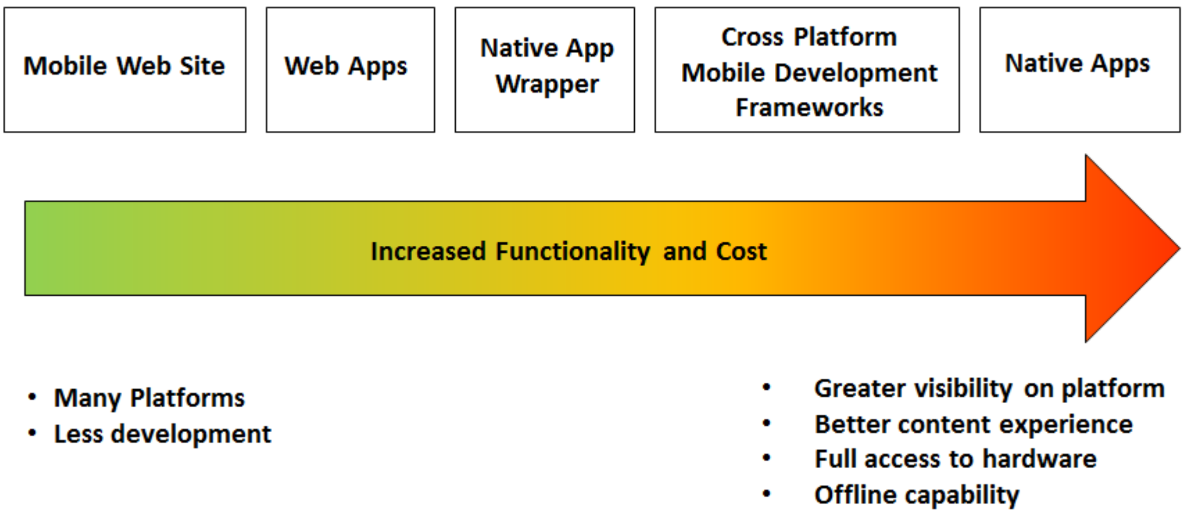


**Figure 13: Advantages and disadvantages of different app development methods**

# 7 Development tools

One of the aims of this survey was to uncover which tools are being used to develop apps, what expertise in using these tools existed, how reusable these tools are (both technically and from an IPR perspective), what efforts are being made to promote potential reuse and how successful such reuse has been. A wide range of tools were uncovered and these are listed in Appendix 3.

Many of these tools are code libraries for presenting interactive maps (Esri SDK, Route-Me, Leaflet, Google maps API, OpenLayers). Although cross-platform development frameworks were expected to be widely used across European geological surveys, no such tools were identified by the survey. A possible task resulting from this survey would be for geological surveys to collaboratively review such frameworks. Such a review should attempt to understand their usefulness for the sector and to estimate how successfully they might integrate with the current tools identified as being in use to underpin existing app developments and maintenance.

Concerning the reuse of the identified tools, from a licencing perspective, many of these tools are open source or free to use (Figure 14). There was also a strong consensus by those who have used the tools that they were straightforward for developers to use with no particular barriers to their reuse. This gives us a sense that the European geological surveys have identified a set of readily available tools that can be re-used by other developers in other organisations (both geology and non-geology related). The geosciences sector also has the expertise within its community to help facilitate that reuse. It is also clear from the survey, however, that little effort has been made in promoting the availability of these tools and their potential reuse (Figure 15). Such activities would be another potential avenue to explore based on this study.

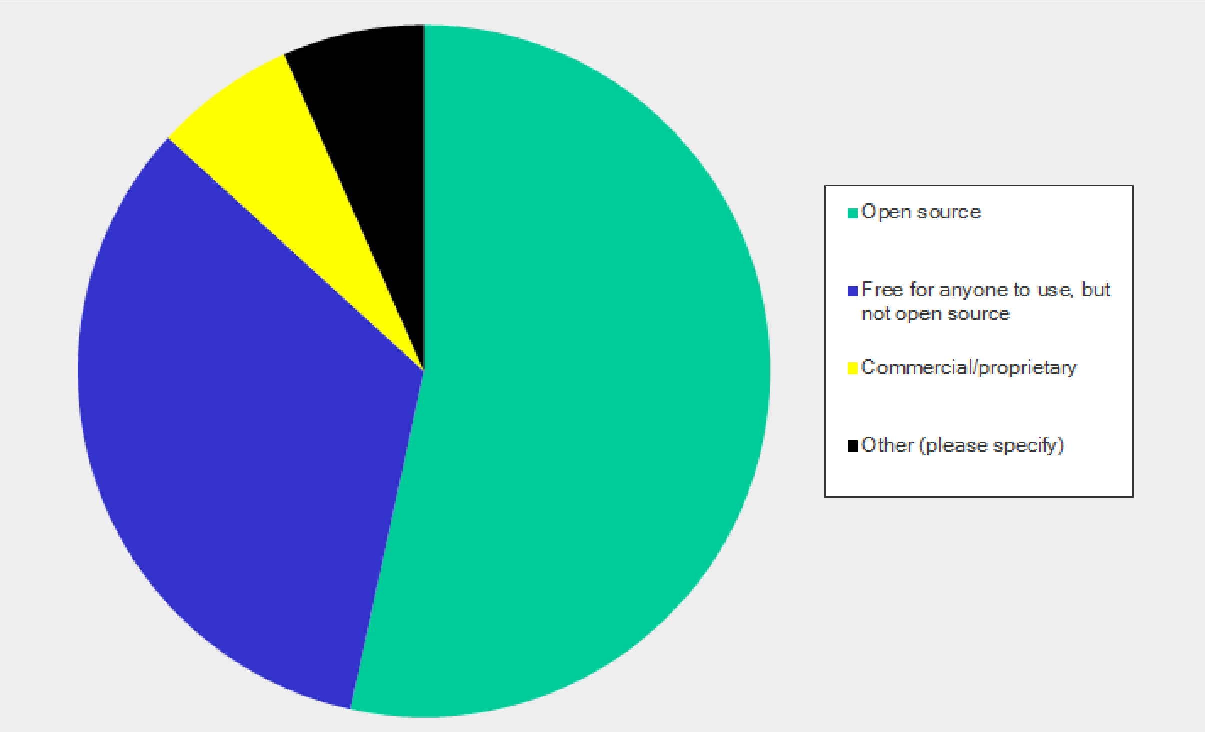


**Figure 14: Licencing conditions of app development tools**

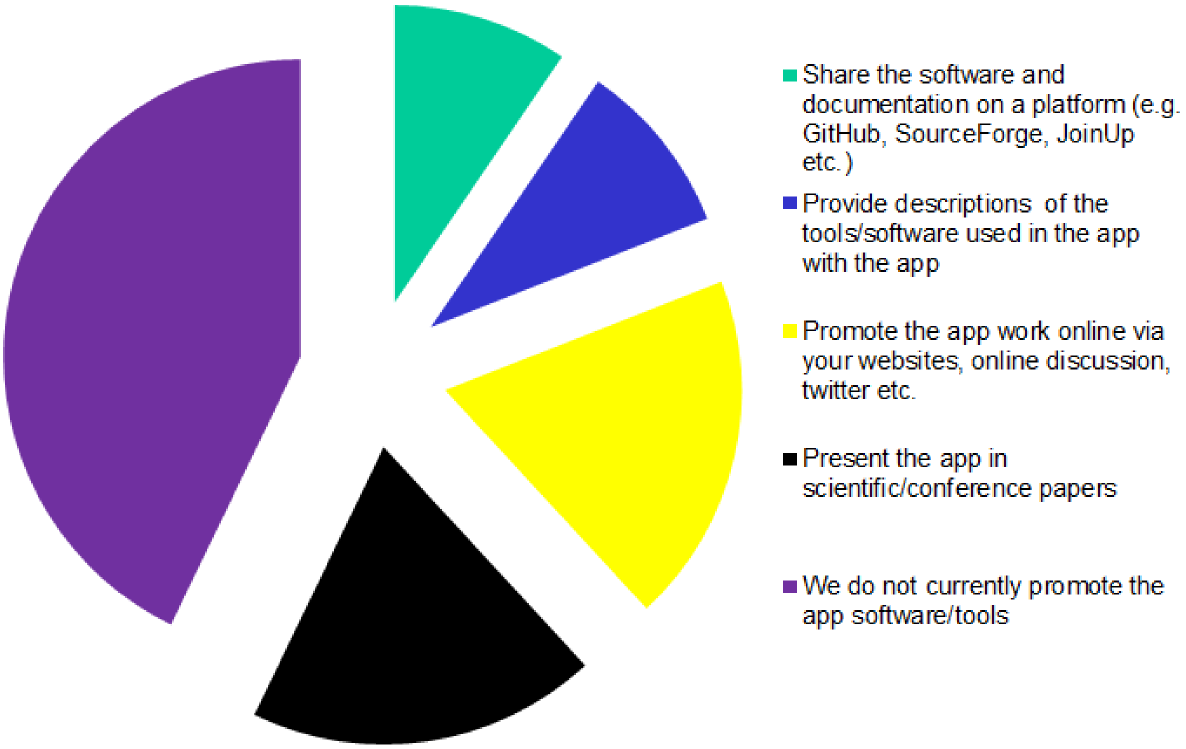


**Figure 15: Efforts by geological survey organisations to promote reuse of tools they use for app development**

## 8 Data delivery

Based on the survey responses, the main purpose of 70% of the apps is to deliver data. When asked what types of data were provided, it was clear that a wide range of data and information across the geosciences sector is being supplied. The vast majority is spatial data and is being presented via a mapping interface. Geological mapping information is most commonly provided as you would expect, but other data includes hydrography, protected sites, digital terrain models, land cover, land use, soils, industrial, agricultural, natural hazards, weather, habitats, minerals and tourism information. Many of these datasets relate to the INSPIRE Directive's 34 Annex Themes. This result also suggests that a rich collection of integrated interdisciplinary apps being developed. 80% of the data provided via apps is also open, freely available data. Such information could be of interest across Europe or across borders as well as in the local area they were intended to serve, but no firm conclusions can be reached based on the survey responses.

We were also interested in whether a web service architecture was being used to provide data to apps. We discovered that an equal split existed between those using web services and those not. The mySoil app from the BGS (and partners Centre for Ecology & Hydrology (CEH), Met Office and the JRC) is an excellent example of the utilisation of web services to power a smartphone app (Figure 16), presenting parent material and soil property information from a range of content providers across Europe . Appendix 1 provides a case study of the BGS approach to mobile app development and includes further details of the use of web services within the mySoil app.

As web services are prevalent in modern application design and the approach to sharing data promoted by INSPIRE, we might have expected the use of web services to be greater.


**Figure 16: Screenshots from the BGS, CEH, Met Office, JRC mySoil app**

We wanted to know more about the role of INSPIRE and whether it had influenced/encouraged/facilitated the creation of apps that deliver data, contributing to the wider dissemination of spatial environmental information through the use of smartphone technology. Many of these questions were sparsely answered. We, therefore, do not have clear answers to questions asking whether web services were specifically developed for use in apps, whether such web services have been reused in other applications or whether app creators are incorporating third-party provided web services in their app. Such details could be followed-up through other studies involving qualitative research with relevant stakeholders.

Regarding INSPIRE, only 25% of the responders actively involved in developing apps stated that it had influenced or helped them make information available via apps and that it had influenced the design and architecture of their apps. As INSPIRE is still being implemented and not intended for app development as its key purpose, this figure should be expected. The other 75% of responders indicated that other frameworks/infrastructures/standards/best practice had a more significant influence on their development. They also, however, indicated that such frameworks could be readily applied outside of the geology community for use in other scientific domains. Some of the details provided for these alternative frameworks are potentially at odds with the low response regarding the direct influence of INSPIRE. In addition to RESTful web services, other alternative frameworks listed included Open Geospatial Consortium (OGC) web services, EuroGeoSource and OneGeology Europe which are in fact closely connected with INSPIRE and its principles.

## 9 Data collection

As well as using apps to deliver information, we also wanted to know if people are using apps to collect information. In general, data collection is a function that was less prevalent than we expected with 75% of respondents stating that no such capability was included in their apps. Some examples exist and we have previously cited a Fieldwork from GEUS as a good example of an app used for professional data capture activities. mySoil from BGS demonstrates how apps can be used to facilitate citizen science data collection. Smartphone technology can be seen as an important tool when such activities involve fieldwork. The BGS case study in Appendix 1 demonstrates how the mySoil app has been used to collect over 1,500 soil property samples from gardeners and other interested users. Developing an engaged community is key to successful citizen science projects. Sharing approaches to community engagement using such devices may be beneficial. It is essential to provide feedback to the community, showing users the results coming from the information they have collected. A clear plan is required for what data is to be collected, why it is needed and how it will be used. In many cases there is also a need to validate and verify data submissions. This can be time consuming and expensive, particularly for factual observations but it may also be possible to reduce this by engaging (trained) citizens in validation activities. The collected data needs to be well managed. Who owns the data, how will privacy and sensitive data issues be dealt with and if a 'take-down'/data removal policy is required are all issues that need to be addressed. In addition, the speed of information collection should also be considered alongside trade-offs between obtaining large amounts of low quality data and a smaller quantity of higher quality data. Another outcome of this survey might be to investigate how European Geological Surveys can extend their use of smartphone technology to pursue such activities.

## 10 Success of apps

We wanted to assess how successful app development has been within European Geological Surveys and whether it should be encouraged more widely, including the interests of app users. An obvious metric is the number of downloads of the apps (Figure 17). Many apps are proving popular and successfully bringing the work of the geological surveys to a wide audience but many organisations were not recording or reporting download figures. Another outcome of this survey, therefore, should be to encourage the developers of these apps to collect such metrics.

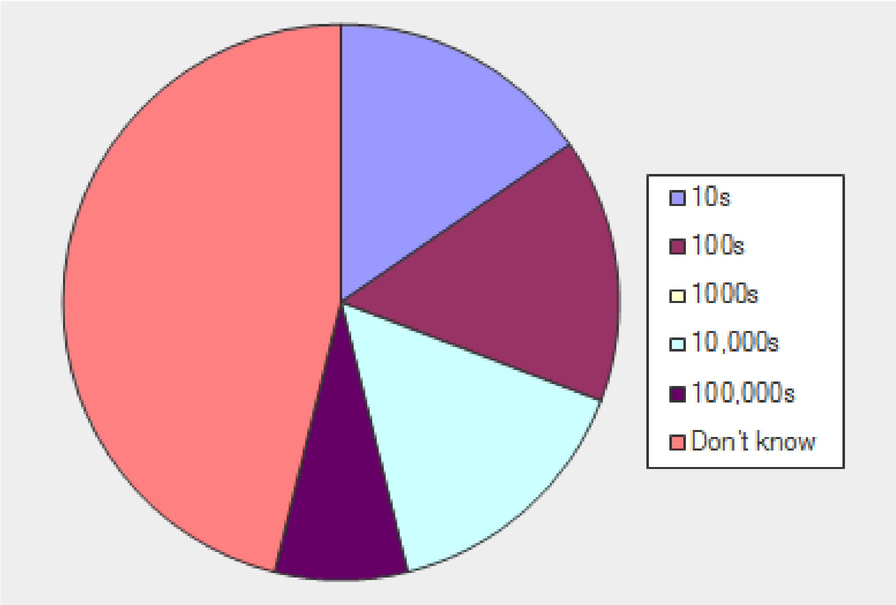


**Figure 17: Download figures for European geological survey apps**

App success is further backed up by some of the positive reviews that developers have been getting for their apps. Some examples are given below.

**"I find this really useful in my role as an agricultural crops advisor…greatly assists with the fertility potential and physical qualities I am likely to encounter"**

**"As geotechnical engineer this is priceless"**

**"Very practical application in the field! Congratulations, keep going"**

**"Well done for offering this app for free!!! Would have easily paid a few pounds**

**for this!!!"**

**"Wow fantastic solution, I hope that it will be further developed."**

**"Very cool application"**

These reviews demonstrate apps are being used by professionals to conduct their work. They show that apps are being used when in the field, providing access to information on the move. They show that users appreciate the new 'cool', inventive ways of presenting information that can be provided via apps. Users are also acknowledging the increased amount of information that is available for free and that they would like to see further developments.

The survey also explored negative comments received about apps, which can be seen to fall into three categories:

1. **The app does not work on my phone** – this reflects the widespread decision to concentrate on Android development and the difficulties in supporting the almost infinite combination of different Android devices and versions of the operating system.
2. **The app currently is not working** – this demonstrates the need to maintain functionality once you have attracted a user base that has become dependent on your app to conduct their professional work or studies.
3. **The app lacks a legend** – this demonstrates the expectations of traditional map users moving to digital delivery methods. The need for a legend is arguably becoming redundant with the ability to tap on any feature to find out more information about what it represents.

Some of the released apps have also been successful in winning awards. The Swedish Geological Survey's app *Geokartan* was rewarded with the Digital Map of the Year prize in 2012 by the Swedish Cartographic Society. The British Geological Survey's iGeology has won awards for innovation in Central Government and was an ESRI International Community favourite winner for best mobile app. These achievements provide further evidence of the impact and high profile that an organisation can gain by creating apps.

## 11 Have apps helped reach a wider audience?

We wanted to learn whether utilising apps as a method of delivering spatial geoscience information had enabled the geological surveys of Europe to reach a wider audience than has thus far been achieved by its traditional methods of information delivery (including from experts to non-professionals). 60% of those developing apps replied that they felt that to be the case and 45% also felt that apps had helped them reach outside of the geology community to introduce their data to a wider range of potential users from other domains. Such results are of interest to ARE3NA and surveys in other sectors could explore how such geology data is consumed and potentially reprocessed. Figure 18 shows who app developers feel are using their apps and Figure 19 demonstrates the activities for which they are using it. It demonstrates a clear use by professional geologists, as one would expect. There is strong use in teaching and by interested amateurs such as tourists and life-long learners, alongside the general public. There is also recognition of professional use of the apps and their data within other sectors such as engineers, agricultural specialists and decision makers. Whilst perhaps circumstantial, this does provide an indication that the apps are expanding the reach of the work of the geological surveys.

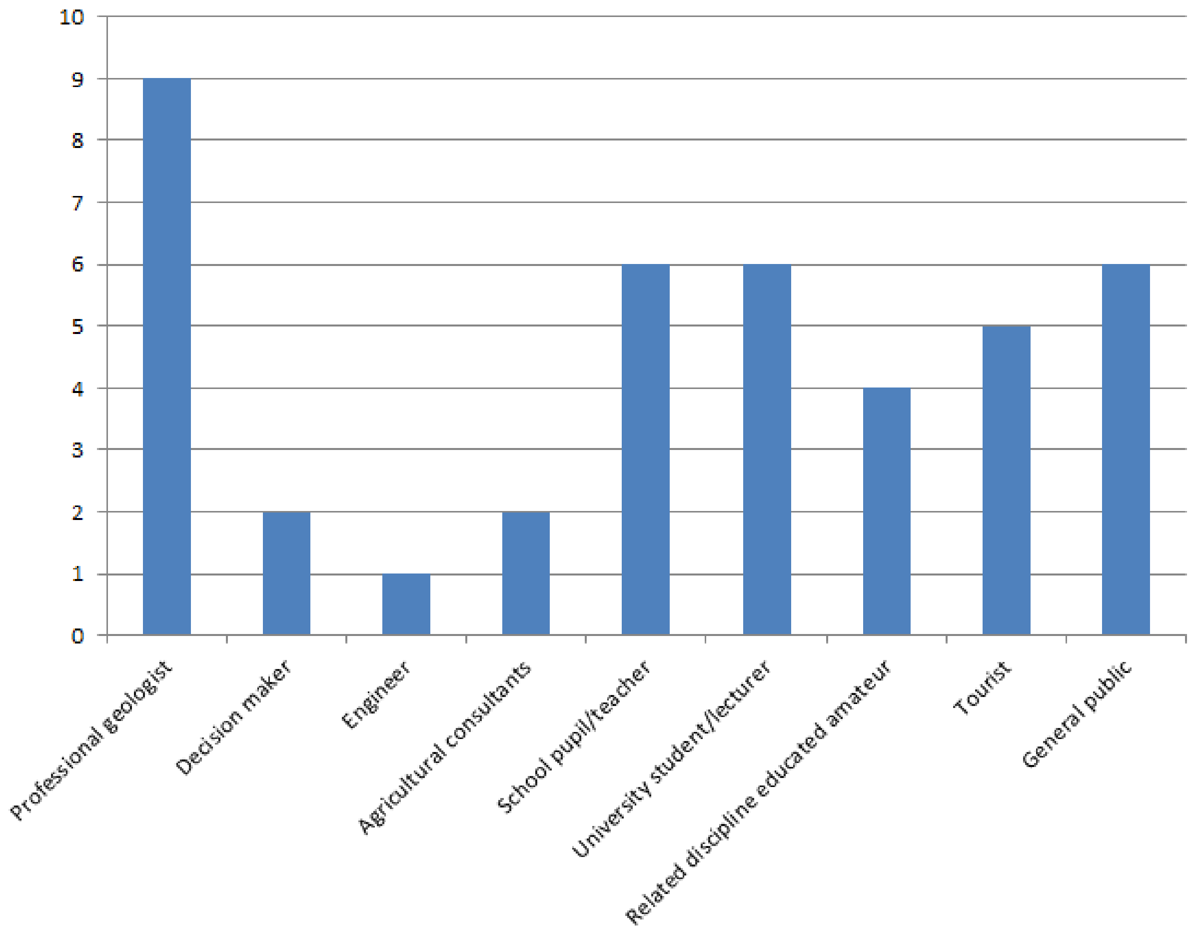


**Figure 18: Range of users utilising apps created by European Geological Surveys**

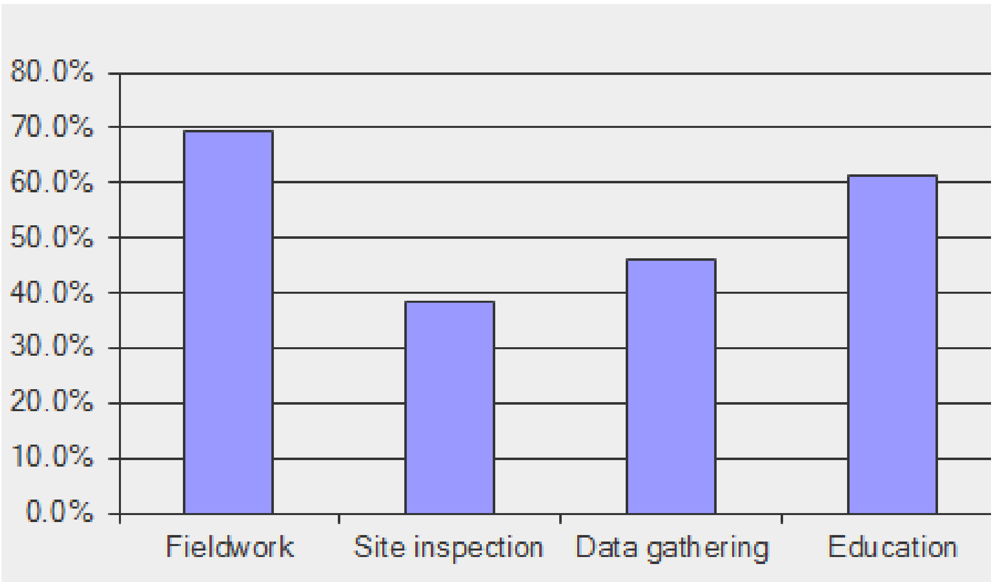


**Figure 19: Activities for which users are using apps**

## 12 Barriers to app development

It was apparent from the survey that many organisations were not involved in app development. Only 18 out of the 33 EuroGeoSurvey members answered the survey and it could be concluded that a good percentage of the abstainers are not engaged in app development activities. Of the 18 that replied, 5 stated that they were not developing apps. We wanted to understand what the European geological surveys felt were the barriers to app development, with Figure 20 summarising the responses.

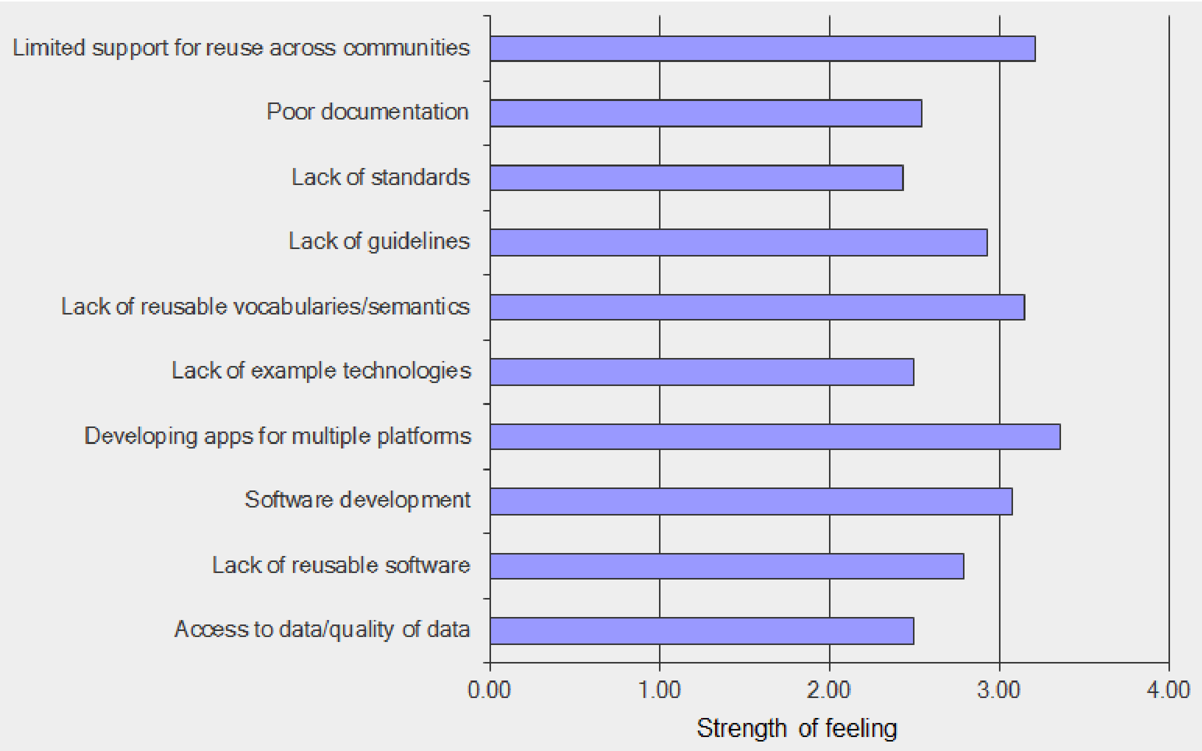


**Figure 20: Barriers to app development**

The need to develop apps for multiple platforms was the most commonly expression barrier, along with limited support for reusable solutions across communities and a lack of reusable semantic vocabularies. Other observed barriers included the financial crisis of recent years and a lack of relevant use cases or organisational interest to engage in such activities. It is hoped that solutions for some of these barriers can come out of this survey.

## 13 Conclusions and moving forward

European geological surveys have widely embraced the use of smartphone apps to deliver geoscience spatial information. Many apps have received thousands of downloads, obtained many positive reviews and won a number of awards. Apps can be seen as a means to enable geological surveys to reach out to a wider audience.

Many skills have been developed and lessons have been learned through these app development activities. In-house development expertise has been gained. Experience has been gathered in a range of open source and free-to-use tools that are considered easy to use. Code and techniques for information visualisation, delivery and collection have been amassed e.g. map interfaces, augmented reality, 3D viewers. All these technologies and techniques are available to be shared with the wider geology and other communities.

A number of the barriers that are perceived to be preventing wider adoption of app development within the geology community are potentially addressed by this survey; the need to support multiple platforms, a lack of software development skills and resource, a lack of reusable software and limited support for reuse across communities. This survey uncovers that these tools and skills do exist and are readily available within the geological community. In particular, the perceived barrier of needing to develop apps for multiple different platforms is addressed through the availability of a range of cross platform development tools and the successful deployment of responsively designed browser-based applications that support multiple mobile devices. The survey also uncovered, however, that more effort needs to be made in promoting the availability of these skills and tools, both within the geology and other communities.

At face value, the survey suggests that INSPIRE has played little or no direct role in the development of apps at this stage of its implementation. However, further examination of the responses might suggest otherwise. There is an acknowledgement that a key function of these apps is to deliver open spatial data in the hope of reaching out to wider audiences. OGC web services are widely used to facilitate this task. Many of the apps developed involve partnership working across different countries and scientific domains. These are all principles and objectives promoted by INSPIRE. Figure 2 indicates that a large number of survey responses came from non-technical responders. It is also possible, therefore, that a lack of understanding of the details of INSPIRE may have prevented the survey uncovering an acknowledgement of the Directive's role in facilitating the development of apps.

It is hoped that the results of this survey will encourage more organisations to engage in mobile app development, across European geological surveys and beyond. In replying to the survey, participants acknowledged that mobile development needs to be taken more seriously as the popularity of mobile solutions and use of mobile devices grows. Respondents were excited about the new capabilities offered by mobile technologies, including augmented reality apps, the use of a device's sensors and the different ways of interacting with user interfaces via eye movement.

There is a clear message from a number of participants that mobile websites and a mixed model of web apps and native apps are required to enable organisations to cover all required platforms. The extra effort needed to create native apps should be reserved for the most popular platforms which are overwhelmingly Android followed by iOS at this moment in time.

Apps are helping to bring people together. They offer interactivity, ease of use and novel opportunities for presenting information. They blur the boundaries with how people interact with other information and communicate in living their everyday life. Delivering information through apps allows organisations to reach technology-aware communities, who are increasingly becoming a large percentage of the population across Europe. In some cases this could even involve citizens. A topic that could be explored in further research.

It is hoped this survey can enable more organisations to get involved in app development based on the experiences and lessons learned by those already involved.

The following actions are suggested to enable this skills sharing to start taking place:

- Create a EuroGeoSurveys mobile apps special interest group that facilitates the sharing of the app development experiences gathered in this survey in more detail
- Create a working group to analyse cross-platform development frameworks
- Encourage greater promotion of available tools that are available for reuse

- Create a working group to encourage use of apps that promote citizen science
- Encourage app creators to monitor download statistics as a measure of impact
- Encourage this survey to be repeated and reported in other sectors so that good practices can be shared across public administrations, research groups and other relevant actors, including extensions or separate investigations to directly identify users' perspectives and impressions of apps

## Appendix 1: Case Study – Mobile app development techniques and strategies at the British Geological Survey (BGS)

The European Union INSPIRE Directive, the United Kingdom's (UK) Location Strategy and the Natural Environment Research Council Information Strategy all require that BGS provides access to its information and data holdings in flexible and interoperable ways that maximises access and encourages innovative uses by stakeholders.

The BGS iGeology app goes some way to address this by providing a mechanism for the general public, academia and businesses to access the digital geology mapping at 1:50,000 scale for the whole of the UK on a mobile device (Figure 21)

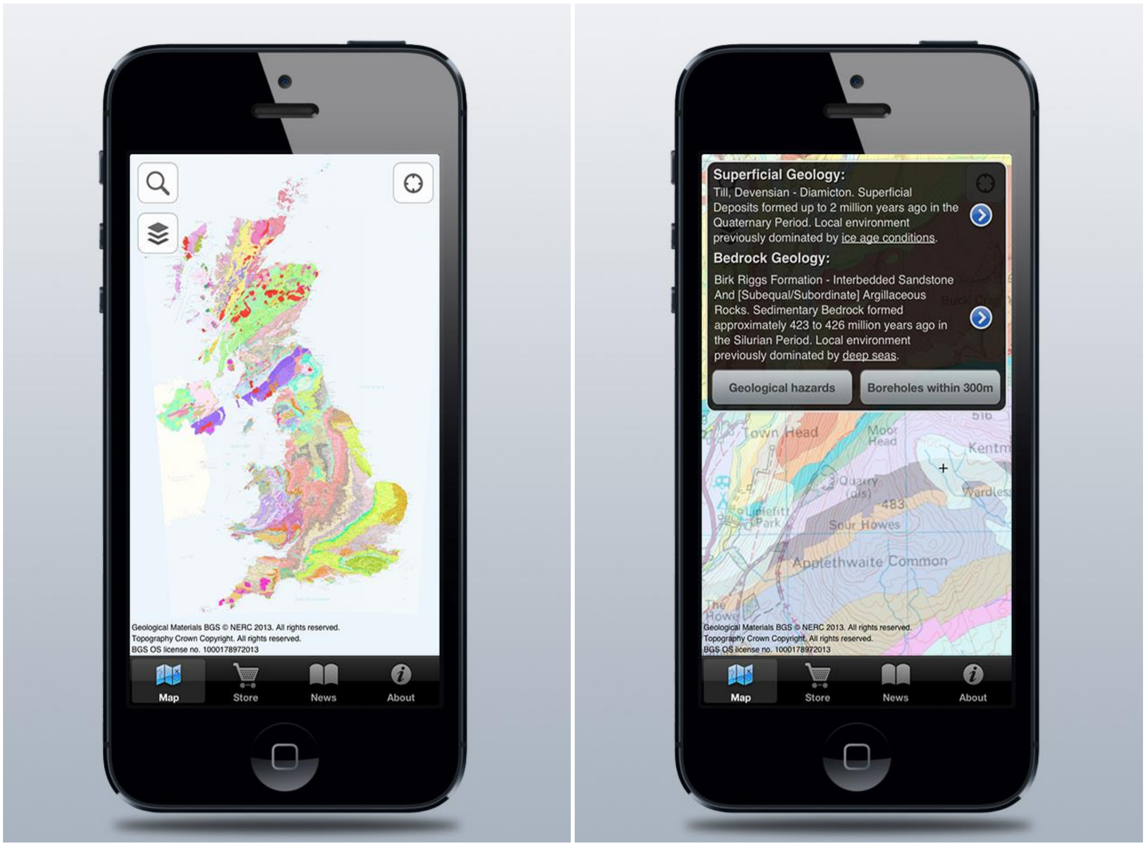


**Figure 21: Screenshots from the BGS iGeology app**

The reach of traditional media channels continues to be eroded by the rapid spread of web-based alternatives, especially on mobile devices. It is anticipated that the proportion of internet traffic accessed using mobile devices will surpass that accessed using desktop computers in 2014 (WPP, 2014)[2]. So it is no surprise that the delivery of BGS data to mobile platforms through bespoke 'mobile apps' is a key element of its open data delivery and communications strategy. Current user feedback demonstrates that these apps have stimulated significant public engagement, created economic benefits for commercial users and encouraged a general interest in the geological sciences. For example:

[2] WPP (2014) 10 GLOBAL COMMUNICATION TRENDS IN 2014. Available from: *http://www.wpp.com/wpp/marketing/publicrelations/10-global-communication-trends-2014*

*"Fantastic to have this information at your fingertips. I use it regularly in my job as a wildlife and natural history interpreter - thank you NERC[3]."*

*"Extremely useful for my career as an Arboricultural consultant (specifically the ease if obtaining very low cost subsidence reports on site almost instantaneously)."*

*"The updates to this app are just brilliant. Thank you for a superb reference application."*

**http://www.bgs.ac.uk/data/apps/igeology/reviews.html**

Since its launch iGeology has been downloaded over 180,000 times from 123 countries around the world. It was featured on BBC Radio 4's Material World and was the No.1 free education application when it was launched. There have been over 100 million map requests through the iGeology app (Figure 22), demonstrating that users are ready to receive geology information in this way. iGeology is now being used to provide additional commercial services, offering in-app purchases for site assessment reports relating to natural subsidence and radon risk. This enables BGS to deploy a freemium business model approach to information delivery services via its mobile apps and provides users with immediate access to value-added information when in the field.

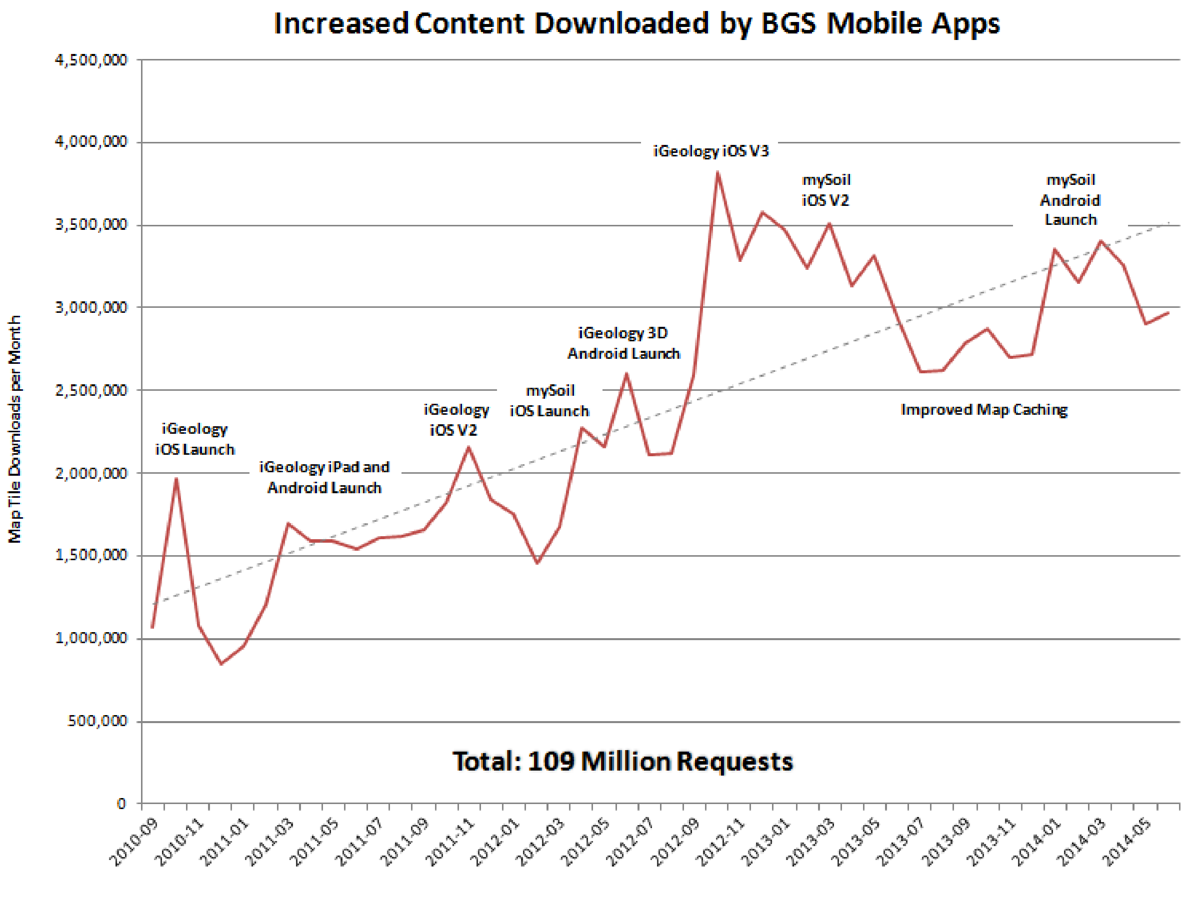


**Figure 22: Increasing numbers of map requests from BGS mobile apps over time**

[3] The UK's Natural Environment Research Council

The technology BGS has developed and utilised to provide its smartphone apps is generic and can be applied to other scientific datasets worldwide. For example, the core iGeology code was repurposed to develop the European 'mySoil' app. Furthermore, the 'iGeology 3D' augmented reality app (Figure 23), which overlays geological information on the landscape around you could also be re-purposed to overlay any spatial data from any discipline on top of an augmented reality landscape.


**Figure 23: Screenshots from the BGS iGeology 3D app**

iGeology was developed as a fully 'native' app, which gives the user the best user experience and allows the app full access to the hardware capability of the device. Unfortunately, creating native apps for each mobile platform requires developing the app in different languages and development environment e.g.

- Objective C for Apple iOS
- Java for Android
- .NET for Windows Phone
- C++ for Symbian

BGS did not have the resources or skills to develop an application for each platform, so had to develop a strategy to maximise platform support without compromising usability. BGS's current strategy is to only support native app development on the two leading smartphone platforms, currently iOS and Android. Their experience has shown that in the UK over 70% of their mobile user base is iOS. Therefore such apps will be developed for this platform first. If they don't prove to have the impact expected after an agreed assessment period then lower cost developments will be employed to support Android and other platforms (e.g. mobile websites).

Another strategy employed to reduce the development costs in supporting multiple platforms has been to utilise a web service architecture. This methodology has been particularly successful in mySoil which brings together soil information from different research centres and presents them seamlessly in an easy-to-use mobile app (Figure 24). Users of mySoil can view soil maps of the UK and EU that provide regional information on soil depth, texture, pH, temperature and organic-matter content and vegetation habitats. Initially developed by the British Geological Survey (BGS) and Centre for Ecology and Hydrology (CEH), it has recently expanded with partnerships to include data from the Met Office and Joint Research Centre (JRC).


**Figure 24: Screenshots from the BGS, CEH, Met Office, JRC mySoil app**

Users can also upload photos and descriptions of their local soils, thus contributing to a valuable data bank of soil properties in different localities (Figure 25). The additional soil property information that is gathered is linked to a geographically referenced point location. Information collected by citizens is presented alongside information from research centres, enabling visual comparison of different datasets. The citizen gathered information is collected under a Creative Commons licence, creating a community owned dataset that can be used for many different purposes. Research centres can use the data to validate and improve their existing datasets and information products. Businesses and other organizations can use the data to create new products. The remarkable success of collecting data in this way reflects widespread public interest and promotes communication with the science community.


**Figure 25: Citizen science soil records collected via the mySoil mobile app and re-presented via web services in the UK Soil Observatory portal**

In order to support as many users and platforms as possible, mySoil was developed as a lightweight client, connected to platform independent web services. Each distributed partner of mySoil (BGS, CEH, Met Office and JRC) developed and hosted web services that were designed to comply with the Open Geospatial Consortium web map service (WMS) and INSPIRE standards. This allowed the bulk of the data preparation, management and rendering to be completed on the server of each host organisation. The results are then served in a simple form that the client 'app' can process and display.

By using a web service architectural approach mySoil could be delivered via an iOS app (iPhone/iPad), an Android app and a web interface. All the applications used the same underlying web services, which not only reduces the development cost, but it also means that the data can be updated remotely by the individual host organisations without updating the client software, decentralising the whole update process.

## Appendix 2: Inventory of released apps from European geological surveys obtained from survey responses and review of app stores

| App name | Provider | Purposes | Platforms | Further information |
|---|---|---|---|---|
| Apps obtained from survey responses | | | | |
| aFieldWork | GEUS | Data collection | Android | https://play.google.com/store/apps/details?id=dk.andsen.fieldwork&hl=en |
| GeoTreat | SGU, GEUS, NGU coorperation | GeoTourism | Android | https://play.google.com/store/apps/details?id=se.sgu.android.geotreat&hl=en_GB |
| i-InfoTerre | BRGM | Present maps and data | iOS, Android | http://infoterre.brgm.fr/i-infoterre |
| InfoGeol | BRGM | Present maps and data | iOS | http://infoterre.brgm.fr/infogeol |
| InfoNappe | BRGM | Present maps and data | iOS, Android | http://infoterre.brgm.fr/infonappe |
| EuroGeoSource | EU project | Present maps and data | Android | http://www.eurogeosource.eu/ |
| Maps4You | Emilia-Romagna, Italy | Present maps and data, GeoTourism | Android | https://play.google.com/store/apps/details?id=it.semenda.moka&hl=en |
| iGeology | BGS | Present maps and data | iOS, Android | http://www.bgs.ac.uk/iGeology/ |
| iGeology 3D | BGS | Present maps and data | Android, Kindle | http://www.bgs.ac.uk/iGeology/3d.html |
| mySoil | BGS | Present maps and data, Data collection | iOS, Android, Kindle | http://www.bgs.ac.uk/mySoil/ |
| myVolcano | BGS | Present maps and data, Data collection | iOS | http://www.bgs.ac.uk/myVolcano/ |

| | | | | |
|---|---|---|---|---|
| Geokartan | Geological Survey of Sweden | Present maps and data | Android | https://play.google.com/store/apps/de-tails?id=se.sgu.android.geokartan&hl=en |
| ArcGIS Online - geologicka mapa | Czech Geo-logical Sur-vey | Present maps and data | Mobile browser | http://www.arcgis.com/home/item.html?id=9276c2088a594b3ab784a5f109f175b9 |
| ArcGIS Online - geologicke lokality | Czech Geo-logical Sur-vey | Present maps and data | Mobile browser | http://www.arcgis.com/home/item.html?id=3b63ea11e785474a85a473f7cc4df26f |
| Geologia | PGI | Present maps and data | Mobile browser | http://geoportal.pgi.gov.pl/portal/page/portal/PIGMainExtranet |
| Additional apps obtain from review of app stores | | | | |
| Ondernl | TNO | Present maps and data | iOS | https://www.tno.nl/content.cfm?context=overtno&content=overtnoapp&laag1=1195&item_id=170&Taal=2 |
| Geo Mal-lorca | Ltim (for IGME) | Present maps and data, geoTourism | Android | https://play.google.com/store/apps/de-tails?id=com.letitguide.geomallorca&hl=en |
| Geologia Italia | Maps from Ministre dell'Ambi-ente - app developed inde-pendently by ITACASOFT | Present maps and data | Android | https://play.google.com/store/apps/de-tails?id=com.itacasoft.geologiaitalia |
| GeoMudel | Estonian Geological Survey | Present maps and data | Android, iOS | https://play.google.com/store/apps/de-tails?id=com.Nortal.GeoMudel2&hl=en |

## Appendix 3: Tools inventory used in the creation of European geological survey apps

| Tool name | Licencing | Description | Further information |
|---|---|---|---|
| ArcGIS iOS and Android SDK | Free to use | Enable development of apps based on ArcGIS Server functionality | http://www.esri.com/software/arcgis/smartphones/develop |
| Route-Me | Open source | iOS map library | https://github.com/route-me/route-me |
| Leaflet | Open source | JavaScript library for mobile-friendly interactive maps | http://leafletjs.com/ |
| Google Maps Android API | Open source | Create apps based on Google Maps | https://developers.google.com/maps/documentation/android/ |
| Libgdx | Open source | Desktop/Android/BlackBerry/iOS/HTML5 Java game development framework | http://libgdx.badlogicgames.com/ |
| Apache Cordova | Open source | Set of device APIs that allow a mobile app developer to access native device function such as the camera or accelerometer from JavaScript. | http://cordova.apache.org/ |
| OpenLayers | Open source | Javascript mapping library | http://openlayers.org/ |
| ArcGIS Online | Commercial | Mapping platform | http://www.esri.com/software/arcgis/arcgisonline |
| Java tools (Eclipse etc) | Open source | General Java development tools for creating Android apps | http://www.eclipse.org/jdt/ |
| Spatialite | Open source | library extending SQLite to provide spatial capabilities | http://www.gaia-gis.it/gaia-sins/ |
| map.apps | Commercial | Mapping application toolkit | http://www.conterra.de/en/products/mapapps/ |

## Appendix 4: Questionnaire Survey

# EuroGeoSurveys geology smartphone apps review

## Introduction

Smartphone apps are being used increasingly across Europe to provide geoscience information and solutions. This survey has been designed to help EuroGeoSurveys members and the wider geological community across Europe discover more about work being undertaken and how organisations not yet active in this area can learn and benefit from those that have already taken some first steps. We are keen to find out who are creating smartphone apps to deliver geoscience information, what approaches they have taken, what tools they have used and how successful their initiatives have been. We would like to assess how other organisations might learn from the experiences of others and whether software, tools, methodologies, good practice have been created that could be reused. We would like to better understand what types of users are being reached by smartphone apps and whether these tools have created new uses for geoscience spatial data by new user groups.

This survey is being conducted by the British Geological Survey, a component institute of the Natural Environment Research Council (NERC), who has had a good deal of success using smartphone apps to deliver geoscience information. The survey is sponsored by the European Commission's Joint Research Centre through the EU ISA Programme's Action, A Reusable INSPIRE Reference Platform (ARE3NA). ARE3NA aims to support access to common reusable software for spatial data and is keen to discover how lessons learnt developing smartphone apps within the geosciences can be applied in other communities. Are3na are also interested in understanding whether INSPIRE (European Union Directive, in force since 2007, to establish a Spatial Data Infrastructure in Europe) has played a role in facilitating the successful development of such apps.

We would be grateful if you could spend 15-20 minutes completing the survey. If you have any questions, please contact Patrick Bell (British Geological Survey).

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

EuroGeoSurveys
European Geoscience for Society

ARe³NA

INSPIRE · Infrastructure for Spatial Information in Europe

## Contact details

***1. Name**

***2. Organisation**

***3. Role in organisation**

# EuroGeoSurveys geology smartphone apps review

***4. Are you happy to be contacted about your responses?**

- ◯ Yes
- ◯ No

**5. If so, please provide an email address.**

## About your apps

***6. Do you have apps or plan to develop them?**

- ◯ Yes
- ◯ No
- ◯ Don't know

## Tell us more about your apps

***7. Please list the names of your apps (enter up to 5 apps)**

1
2
3
4
5

***8. What range of uses are covered by your apps (tick all that apply)?**

- ☐ Present map data or 3D model data
- ☐ Data collection
- ☐ Tools (e.g. clinometer)
- ☐ Education
- ☐ Publication/Journal
- ☐ Reference (e.g. geological dictionary)
- ☐ Tourism
- ☐ Entertainment/games
- ☐ Other (please specify)

**9. What apps are you working on/planning for the future?**

## EuroGeoSurveys geology smartphone apps review

*** 10. What range of mobile operating systems do your apps support (tick all that apply)?**

- [ ] iOS (iPhone/iPad)
- [ ] Android
- [ ] Kindle
- [ ] Windows
- [ ] Blackberry
- [ ] Symbian
- [ ] Other (please specify)

*** 11. What do you see is the most important mobile operating systems to support?**

- ◯ iOS (iPhone/iPad)
- ◯ Android
- ◯ Kindle
- ◯ Windows
- ◯ Blackberry
- ◯ Symbian
- ◯ Other (please specify)

*** 12. Are your apps free or do you charge for them (tick all that apply)?**

- [ ] Free app
- [ ] Charged app
- [ ] In-App Purchases
- [ ] Other (please specify)

*** 13. When did you publish your first app (enter month and year)?**

*** 14. How often do you update your apps?**

- ◯ Weekly
- ◯ Monthly
- ◯ Yearly
- ◯ Never

# EuroGeoSurveys geology smartphone apps review

## More about your apps

*** 15. Please tell us why you currently have no apps or any plans to develop them (tick all that apply).**

- [ ] No interest
- [ ] Not a priority
- [ ] Limited expertise
- [ ] No available data
- [ ] Other (please specify)

## App development - who is involved?

*** 16. Who develops your apps (tick all that apply)?**

- [ ] We have in-house developers
- [ ] We contract out to specialist developers
- [ ] We publish data in formats (with appropriate licences) that allow others to develop apps
- [ ] Other (please specify)

*** 17. Do you develop apps in partnership?**

- ◯ Yes
- ◯ No
- ◯ Don't know

## App development - partners

*** 18. Are these app development partners from inside or outside of the geology community?**

- ◯ Inside
- ◯ Outside
- ◯ Both
- ◯ Don't know

## EuroGeoSurveys geology smartphone apps review

### *19. Are these app development partners from your own or other countries?

- ◯ Own
- ◯ Other
- ◯ Both
- ◯ Don't know

## App development - what technologies are involved?

### *20. In general, how are your apps implemented (tick all that apply)?

- ☐ We develop individual, native apps, coded specifically for each platform
- ☐ We utilise cross platform frameworks and native app wrappers
- ☐ We focus on browser-based mobile websites
- ☐ Other (please specify)

**Please provide more specific details of software, tools, components or frameworks that you have used to help develop your apps e.g. PhoneGap, Appcelerator, iFactr, ESRI iOS SDK, Route-Me map library etc. Please describe up to five tools.**

### 21. Please enter details of a development tool you have used

Name of tool

Description of tool

Link to tool

### 22. What are the licencing conditions for this tool?

- ◯ Open source
- ◯ Free for anyone to use, but not open source
- ◯ Commercial/proprietary
- ◯ Other (please specify)

### 23. What effort do you think will be needed to reuse the tool in another organisation?

- ◯ Straightforward
- ◯ Difficult
- ◯ Not possible
- ◯ Don't know

## EuroGeoSurveys geology smartphone apps review

***24. Do you have another tool to tell us about?**

- ◯ Yes
- ◯ No

### App development - second development tool

**25. Please enter details of another development tool you have used**

Name of tool

Description of tool

Link to tool

**26. What are the licencing conditions for this tool?**

- ◯ Open source
- ◯ Free for anyone to use, but not open source
- ◯ Commercial/proprietary
- ◯ Other (please specify)

**27. What effort do you think will be needed to reuse the tool in another organisation?**

- ◯ Straightforward
- ◯ Difficult
- ◯ Not possible
- ◯ Don't know

***28. Do you have another tool to tell us about?**

- ◯ Yes
- ◯ No

### App development - third development tool

**29. Please enter details of another development tool you have used**

Name of tool

Description of tool

Link to tool

## EuroGeoSurveys geology smartphone apps review

**30. What are the licencing conditions for this tool?**

- ◯ Open source
- ◯ Free for anyone to use, but not open source
- ◯ Commercial/proprietary
- ◯ Other (please specify)

**31. What effort do you think will be needed to reuse the tool in another organisation?**

- ◯ Straightforward
- ◯ Difficult
- ◯ Not possible
- ◯ Don't know

*** 32. Do you have another tool to tell us about?**

- ◯ Yes
- ◯ No

### App development - fourth development tool

**33. Please enter details of another development tool you have used**

Name of tool

Description of tool

Link to tool

**34. What are the licencing conditions for this tool?**

- ◯ Open source
- ◯ Free for anyone to use, but not open source
- ◯ Commercial/proprietary
- ◯ Other (please specify)

**35. What effort do you think will be needed to reuse the tool in another organisation?**

- ◯ Straightforward
- ◯ Difficult
- ◯ Not possible
- ◯ Don't know

## EuroGeoSurveys geology smartphone apps review

***36. Do you have another tool to tell us about?**

- ◯ Yes
- ◯ No

### App development - fifth development tool

**37. Please enter details of another development tool you have used**

| | |
|---|---|
| Name of tool | |
| Description of tool | |
| Link to tool | |

**38. What are the licencing conditions for this tool?**

- ◯ Open source
- ◯ Free for anyone to use, but not open source
- ◯ Commercial/proprietary
- ◯ Other (please specify)

**39. What effort do you think will be needed to reuse the tool in another organisation?**

- ◯ Straightforward
- ◯ Difficult
- ◯ Not possible
- ◯ Don't know

### App developmement - promoting tool reuse

***40. How do you currently promote the potential reuse of your app or its development tools in both geology and other communities (tick all that apply)?**

- ☐ Share the software and documentation on a platform (e.g. GitHub, SourceForge, JoinUp etc.)
- ☐ Provide descriptions of the tools/software used in the app with the app
- ☐ Promote the app work online via your websites, online discussion, twitter etc.
- ☐ Present the app in scientific/conference papers
- ☐ We do not currently promote the app software/tools
- ☐ Other (please specify)

### App data, information and services

# EuroGeoSurveys geology smartphone apps review

***41. Do you serve data through your apps?**

- ◯ Yes
- ◯ No
- ◯ Don't know

## Serving data through your apps

***42. What data or information topics/themes do you publish via your apps (tick all that apply)?**

- ☐ Geology
- ☐ Topographic
- ☐ Hydrography
- ☐ Transport
- ☐ Protected sites
- ☐ Land cover
- ☐ Elevation/Terrain
- ☐ Land use
- ☐ Soils
- ☐ Engineering
- ☐ Health and safety
- ☐ Utilities
- ☐ Environmental monitoring
- ☐ Industrial
- ☐ Agricultural
- ☐ Demographic
- ☐ Natural risks/hazards
- ☐ Atmospheric
- ☐ Meteorological
- ☐ Oceanographic/Seas
- ☐ Habitats and bio-regions
- ☐ Species distribution
- ☐ Energy
- ☐ Minerals
- ☐ Other (please specify)

# EuroGeoSurveys geology smartphone apps review

***43. Is the data open or charged to view?**

- Open
- Charged
- Both
- Don't know

***44. Is the data open or charged to download?**

- Open
- Charged
- Both
- Don't know

***45. Is the data of interest to users across Europe as well as those within the extent of the dataset?**

- Yes
- No
- Don't know

***46. Do you use advertised web services (that are available for others to use) to provide data to your apps?**

- Yes
- No
- Don't know

## Use of data web services

***47. Have web services for your data been developed specifically for use by your app?**

- Yes
- No
- Don't know

## EuroGeoSurveys geology smartphone apps review

***48. Have any data services that were developed to power your apps been re-used by other organisations in their applications?**

- ○ Yes
- ○ No
- ○ Don't know

**49. Please provide links to such services and to the apps that reused them.**

***50. Do you use services from other organisations in your app?**

- ○ Yes
- ○ No
- ○ Don't know

***51. Do you use services from other countries in your app?**

- ○ Yes
- ○ No
- ○ Don't know

**52. Please provide links to these external services and indicate in which of your apps they are used**

### Using apps to collect data

***53. Do your apps allow users to submit information (tick all that apply)?**

- ☐ Yes, feedback on the app itself (bugs, improvements to design etc.)
- ☐ Yes, crowdsourcing/citizen science/volunteered information to improve existing datasets
- ☐ Yes, crowdsourcing/citizen science/volunteered information to collect new data
- ☐ No

Other (please specify)

## EuroGeoSurveys geology smartphone apps review

**54. Please provide further details of any crowdsourcing/citizen science/volunteered information activities within your apps**

### Evaluating success of your apps

***55. How many downloads have your apps received?**

- ◯ 10s
- ◯ 100s
- ◯ 1000s
- ◯ 10,000s
- ◯ 100,000s
- ◯ Don't know

**56. Provide some sample positive reviews of your apps.**

**57. Provide some sample negative reviews of your apps.**

***58. Have your apps received any prizes/awards?**

- ◯ Yes
- ◯ No
- ◯ Don't know

**59. Please provide further details**

**60. What other information do you use in order to measure and evaluate impact and show value to funders?**

### Evaluating use of your apps

## EuroGeoSurveys geology smartphone apps review

***61. Do you think smartphone apps have helped you reach a wider range of users (from experts to non-professionals)?**

- ◯ Yes
- ◯ No
- ◯ Don't know

***62. Do you think smartphone apps have helped you reach a wider range of communities (from outside the geological community)?**

- ◯ Yes
- ◯ No
- ◯ Don't know

***63. What types of users are using your apps (tick all that apply)?**

- ☐ Professional geologist
- ☐ Decision maker
- ☐ Other professional (please state below)
- ☐ School pupil/teacher
- ☐ University student/lecturer
- ☐ Related discipline educated amateur
- ☐ Tourist
- ☐ General public
- ☐ Other (please specify)

***64. For what purposes/activities do these users make use of your app (tick all that apply)?**

- ☐ Fieldwork
- ☐ Site inspection
- ☐ Data gathering
- ☐ Education
- ☐ Other (please specify)

### Influence of INSPIRE

## EuroGeoSurveys geology smartphone apps review

***65. Do you think INSPIRE has helped you make information available via smartphone apps?**

- ◯ Yes
- ◯ No
- ◯ Don't know

***66. To what extent has INSPIRE influenced the design or architecture of your current and planned apps?**

- ◯ Little or no influence
- ◯ Some minor influence overall
- ◯ Some influence in certain elements of design/architecture
- ◯ Influence on the overall design/architecture

***67. Have any other frameworks/infrastructures/standards/best practice influenced the development of your apps e.g. OGC standards, OneGeology, RESTful services?**

- ◯ Yes
- ◯ No
- ◯ Don't know

***68. Can these frameworks/infrastructures/standards/best practice be applied to other communities outside of the geology community?**

- ◯ Yes
- ◯ No
- ◯ Don't know

**69. Please provide further details of these frameworks/infrastructures/standards/best practice and how they have influenced your app development projects**

### Closing comments

## EuroGeoSurveys geology smartphone apps review

### 70. What are the biggest barriers to wider/better app production?

| | Strongly disagree | Disagree | Neutral | Agree | Strongly agree |
|---|---|---|---|---|---|
| Access to data/quality of data | ◯ | ◯ | ◯ | ◯ | ◯ |
| Lack of reusable software | ◯ | ◯ | ◯ | ◯ | ◯ |
| Software development | ◯ | ◯ | ◯ | ◯ | ◯ |
| Competing/diverging technologies (e.g. developing apps for multiple platforms etc.) | ◯ | ◯ | ◯ | ◯ | ◯ |
| Lack of example technologies | ◯ | ◯ | ◯ | ◯ | ◯ |
| Lack of reusable vocabularies and other forms of support related to semantics | ◯ | ◯ | ◯ | ◯ | ◯ |
| Lack of guidelines | ◯ | ◯ | ◯ | ◯ | ◯ |
| Lack of standards | ◯ | ◯ | ◯ | ◯ | ◯ |
| Poor documentation | ◯ | ◯ | ◯ | ◯ | ◯ |
| Limited support for reuse across communities | ◯ | ◯ | ◯ | ◯ | ◯ |

Other (please specify)

### 71. What do you think are the future trends and technologies related to apps?

### 72. Any further comments you would like to make?