Submission
2016 National Research Infrastructure Roadmap
Capability Issues Paper

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DECADAL PLAN
FOR EARTH SCIENCES
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Questions

Question 1: Are there other capability areas that should be considered?

Whist the Geosciences and Solid Earth Science are considered in the document they are only included in the Environment and Resource Management section. This approach undervalues the research impact that Geoscience (or more broadly Earth Sciences) has internationally as well as the importance of the resources and energy industry to the Australian economy.

The inclusion of a capability area that focuses on the Solid Earth from a Crustal Services perspective (nascent energy systems, subsurface waste and energy storage, groundwater, mineral resources, crustal stability) would serve a significant portion of the research community's needs, and would have strong support from Government (State and Federal Geological Surveys, Surveyors General Departments, Primary Industries etc), as well as industry research users. It would also better align with the Federal Government's stated Science and Research Priorities, which contain both Energy and Resources as separate priority areas.

Geoscience is an integrative science, which through geophysics, geochemistry, geodesy and observational geology provides a connection between the traditional STEM sciences and the Environment and Resource Management sectors. Whilst it is appropriate to consider part of the solid earth geosciences in the Environment and Resource Management capability area, that grouping does not capture the full scope of the pure or applied research being undertaken in the field. Consideration of major aspects of Geoscience in the context of the Physics/Maths/Chemistry grouping as well would be more appropriate. It is pertinent to note that the Australian Academy of Sciences formally endorses the inclusion of Earth Sciences as an integral part of the Advanced Physical Sciences (along with Physics and Chemistry).

The mineral exploration industry, government geological survey organisations and academia have recently collaborated to develop the UNCOVER research initiative. This collaboration is likely to produce a decade-long research program funded from a variety of sources that will have significant research infrastructure requirements ranging from drill-hole access, development and deployment of new monitoring and imaging sensors, national-scale data acquisition collation and delivery programs, specialised data modelling, analytics, discover and machine learning algorithm development.

Additionally, as a minimum, energy should be specifically identified along with environment or else have its own specific capability category.

Question 2: Are these governance characteristics appropriate and are there other factors that should be considered for optimal governance for national research infrastructure.

In our experience the establishment of a not-for profit company with an independent board specifically to invest in, develop and manage that facility or capability provides optimal governance of national research infrastructure facilities. The organisation must have the support of the research community that it represents and must engage widely and have open and transparent management processes in place. This allows for independence from institutional politics, allows for the development of truly national infrastructure and facilitates strategic decision-making for the benefit of the entire community.

The formation of industry and/or science advisory panels, to provide advice to the CEO or to the Board, can greatly enhance community engagement and be valuable in making specific investment decisions where specific sectorial knowledge is critical.

Independent access committees should be put in place to assess meritorious access for use of the infrastructure or facilities.

Whilst the above model has served the Geoscience, Geospatial and Earth Sciences community well, through the development of AuScope Ltd over the last 10 years, there should be recognition that all facilities and capabilities are likely to be very different and so flexibility in the governance structures is important.

Successful governance of National Research Infrastructure Capabilities depends on the ability of the boards to develop medium to long-term strategic plans for the organisations. This requires long-term funding cycles to be secured and should require the development of 5 and 10 year science and investment strategies that align with the broader government, academic and industry research agendas.

Question 3: Should national research infrastructure investment assist with access to international facilities?

Where the case cannot be made for the development of an Australian infrastructure capacity, but there are international facilities that can be accessed, then it is appropriate and prudent to fund access with research infrastructure funds.

Examples may include the International Ocean Drilling Program (IODP) membership or access to facilities such as CERN and international synchrotron facilities.

National infrastructure research investment should not be used to fund research on, or in collaboration with, these facilities but rather to provide access to them through program membership. These memberships should only be purchased with national infrastructure research investment funding where that membership is in the national interest and there are barriers to Australian researcher access to those facilities without it.

Question 4: What are the conditions or scenarios where access to international facilities should be prioritised over developing national facilities?

It is appropriate to consider access to international facilities where overall impact for Australian science does not justify the effort and investment of developing the capability here due either to the cost, scale or broad community need.

Question 5: Should research workforce skills be considered a research infrastructure issue?

Operational workforce *should* definitely be considered a research infrastructure issue but the funding of research-based staff and the undertaking of research utilising that infrastructure should not.

A skilled operational workforce is critical to ensuring that the infrastructure investment serves the research community effectively and provides the best long-term impact for the investment. This workforce can also facilitate the development of Significant National Datasets utilising the infrastructure when not undertaking specific research programs.

Funding researchers and research through infrastructure schemes such as NCRIS is not appropriate as it will reduce the ability of those schemes to fund the research infrastructure requirements of the entire national research community, it will complicate the relationship between NCRIS and research funding sources such as ARC and NHMRC and will run the risk of focussing on funding expensive research projects rather than the development of research infrastructure capability that serves the wider Australian research community.

Question 8: What principles should be applied for access to national research infrastructure, and are there situations when these should not apply?

National research infrastructure should broadly follow existing NCRIS guidelines - access for little or no cost to Australian researchers, data made widely and freely available as soon as possible after collection, industry access with some cost recovery to support the infrastructure but with guidelines in place to ensure that research facility operation complies with competitive neutrality principles in relation to Australian commercial research or analysis providers.

Question 9: What should the criteria and funding arrangements for defunding or decommissioning look like?

The capability should be able to demonstrate broad research community support and ongoing usage for continued support. Where it is clear that: (a) there is no longer a use-case or community need for the capability, (b) new developments, technologies or practices have made the capability unviable and there is no clear path to return the capability to a position of effectiveness, or (c) where the capability has had poor governance and is functioning poorly as a result it may be appropriate to defund that capability.

Potential defunding decisions should involve research community consultation to ensure that this really is the best approach for that group.

In these circumstances it is critical that the de-funding is managed appropriately between the department and the capability and that decommissioning plans are put in place to transition skilled staff into other positions over reasonable timeframes.

Question 10: What financing models should the Government consider to support investment in national research infrastructure?

There is clear evidence from many studies around the world that long-term, strategic funding provides far greater “bang-for-buck” than short-term *ad hoc* funding. The Australian government has often said that it wants science to help drive forward the Australian economy. This can only happen by choosing to transform science into a genuine national capability, as has happened in the United States of America. This means that science needs to be funded as a genuine national strategic capability and then used as a national strategic capability.

The Australian Government needs to change its perception of science from a "cost" to an investment in the nation. This will require cultural change to the point where the Australian Government is willing to articulate a genuine science strategy, clearly articulate its priorities as to the areas where science can constitute genuine underpinning infrastructure for national development, allow the scientific community to develop genuinely effective responses with longer-term funding, and then respect and value the impact that the science has.

Question 11: When should capabilities be expected to address standard and accreditation requirements?

Where a topic is being pursued in close collaboration with industry, it is likely industry standards have to be adhered to. Where a baseline study relating for example to an environmental issue is being undertaken, which could have a significance decades ahead, then standards and perhaps accreditation must be adhered to.

Environment and Natural Resource Management

Question 18: Are the identified emerging directions and research infrastructure capabilities for Environment and Natural Resource Management right? Are there any missing or additional needed?

The link between understanding the solid earth (the geosphere) and its relationships to the hydrosphere, biosphere and atmosphere will be critical to research and application in this space over the next decade - this link is not adequately identified in the current document.

A Crustal Services approach to our consideration of resources provides a pathway to strengthen this link. What "services" do the Earth's crust provide to us and what science needs to be undertaken and what research infrastructure needs to be in place to allow us to utilise these services to benefit Australian society?

In order to facilitate this type of research, on the scale of the Australian Continent, an integrated network of sensors for geophysical and geochemical sampling and analysis is required. This deployment would build on existing AuScope infrastructure and Geoscience Australia data acquisition programs and will create a geological "telescope", that looks into the Earth not away from it. This could be considered equivalent to a Geoscience *Ten Million Square Kilometre Array* (see also response to Question 20). This very large research infrastructure investment will support research from applied mineral discovery, to new energy systems as well as the underlying fundamental research that facilitates our understanding of how the earth works and how it supports life and society.

A series of key science questions, developed in consultation with and seen as critical to the earth and geospatial science community over the next decade, are articulated in more detail in the AuScope Australian Earth Observing System strategic overview document which is available for download from http://www.auscope.org.au/future-directions/

A significant national consultation campaign on behalf of the UNCOVER Research Initiative has clearly stated the need for collaborative industry-academic research programs to better understand the covered regions of the Australian mainland and offshore regions. The case for these programs and some consideration to supporting infrastructure requirements is outlined in the UNCOVER Roadmap. http://www.uncoverminerals.org.au/documents/amira-uncover-roadmap

Question 19: Are there any international research infrastructure collaborations or emerging projects that Australia should engage in over the next ten years and beyond?

- EarthCube and its European equivalents - data and data delivery
- USArray and IRIS – Geophysics and earth observation
- International Ocean Drilling Program
- International Synchrotron facilities (USA, Japan, Europe)

Question 20: Is there anything else that needs to be included or considered in the 2016 Roadmap for the Environment and Natural Resource Management capability area?

Australia needs to develop an integrated distributed network of geophysical and remote sensor deployments and geochemical sampling and analysis that will form a geological telescope - looking inward not outward - supporting research from applied mineral discovery (UNCOVER) to new energy systems (unconventional gas, waste storage and geothermal – extending the AusDEEP concept regionally). Nationally and internationally significant open file datasets produced by these deployments will provide the currently missing links between solid earth geophysics and geoscience, geodesy and geospatial analysis of the earth's response to natural and human activity, mineral and energy system science, groundwater mapping and modelling and links to agricultural, biological, ocean and climate science research and monitoring systems.

This multi-sensor network - analogous to, but more ambitious than the USAarray, will provide time series data that will facilitate research enterprise ranging from the analysis of the evolution of our planet and continent, to the development of our energy and mineral deposits, groundwater systems and soils. It will facilitate integrative science that will have direct impact within government and industry and will provide datasets that will underpin informed policy development by allowing monitoring of human impacts on the earth and its systems.

These datasets, and related simulation models utilising existing and new technologies that consume the data, provide 3D and 4D models of the Australian crust and facilitate prediction of natural and human induced changes on a variety of temporal and length scales.

Understanding the Earth's crust (the source of all resources for civilisation from water to energy to metal supplies) requires that the deeper Earth is also well characterised. This requires new-generation geophysical and geochemical datasets probing as deeply as possible and extending current knowledge of the lithosphere (the outer Earth's layer to about 200km beneath the surface) as far as possible to the Earth's core at about 3,000km. The heat energy and the movement and composition of the fluids in this deep Earth control the location of surface geological hazards (tsunamis, earthquakes, volcanoes), as well as being the ultimate source of our crustal resources. Again, this reflects the *inner telescope* investigation of Earth's unknown depths introduced above.

Advanced Physics, Chemistry, Mathematics and Materials

Question 21: Are the identified emerging directions and research infrastructure capabilities for Advanced Physics, Chemistry, Mathematics and Materials right? Are there any missing or additional needed?

Many of the current research issues facing the earth and geospatial communities are more strongly aligned with those proposed in the Advanced Physics, Chemistry, Mathematics and Materials sections.

In particular:

(1) Issues relating to the modelling of crustal and mantle evolution, plate tectonics and the physics and chemistry of the solid earth – essentially computationally intensive fluid dynamics and physics modelling
(2) The development of new geophysical imaging tools and related and analytics and in particular advanced inversion codes.
(3) Applications of Synchrotron science to imaging and characterisation of geological materials and related applied processing research.
(4) Precision measurement at varied length scales related to geodetic earth measurement.
(5) High throughput geochemistry laboratory developments which are currently revolutionising geochronology science and mineral exploration processes in Australia.
(6) The development of new sensor technologies for geological mapping and monitoring utilising new deployment technologies such as UAV systems and/or aligned to any new space science programs in this country.
(7) We consider Geoscience to be a fundamental natural science equivalent to Physics and Chemistry (and Biology). Recognition of this by Government will help redress a current imbalance in research funding and provide benefits to all Australians.

National Security

Question 27: Are the identified emerging directions and research infrastructure capabilities for National Security right? Are there any missing or additional needed?

There is no consideration given in the National Security capability section of either energy security or natural resource security. Australia is particularly vulnerable to threats to gas and electricity supply. Concentration of power generation infrastructure in regions of significant seismic hazard (such as the Gippsland Basin) put continuity of supply at significant risk in the event of a moderate to large earthquake.

Better understanding of crustal stability (and the related mantle state) as well as more research into nascent energy technologies is required to address these issues. Of particular importance is additional capability designed to understand the impact of human activity on the state of the Earth's crust. The development of unconventional energy systems and the subsurface storage of waste materials have the potential to trigger significant earthquakes. Significant new deployments of earth monitoring systems across sedimentary basins will facilitate research into human impacts on the state of the crust, the impacts on basin contained resource systems (including groundwater) as well as more fundamental research into the formation of the Australian Plate and its surrounding ocean basins.

Underpinning Research Infrastructure

Question 30: Are the identified emerging directions and research infrastructure capabilities for Underpinning Research Infrastructure right? Are there any missing or additional needed?

The emerging underpinning research infrastructure directions are generally good. Of particular relevance to Geoscience is the critical requirement for: (1) high performance computing, high capacity networks and secure fast storage, (2) increased capacity and precision in the geospatial and earth monitoring space, and (3) digitisation of data to support national scale research programs that rely heavily on historical data, such as the Uncover initiative.