GlassEarth™ Australia Discussion Document

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CSIRO

EXPLORATION & MINING

GEOSCIENCE AUSTRALIA

GlassEarth

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EXECUTIVE SUMMARY

GlassEarth™ Australia is proposed national project to capture and deliver knowledge to all stakeholders about the earth under Australia and the minerals, energy and natural resources that it provides as a foundation for living.

The objective is to create a national consortium of earth scientists, with the core partners CSIRO and Geosscience Australia, to build a knowledge-rich, 4-dimensional "map" of Australia that will be delivered through a highly visual and exstensible web service portal. The portal will provide transparent access to knowledge, information and data for different stakeholder needs ranging from community to policy makers and specialist integrators.

The outcome provides a new, pre-competitive geological framework from which to facilitiate mineral and energy discoveries and their access in terms of the environment. Successful implementation of this project requires federated support from federal and state agencies that provide knowledge and data, small to medium consultancies who provide knowledge transfer and utilisation, and the CSIRO who provide the fundamental technologies and knowledge for integration across all stakeholders.

Funding approaching $12M will be required and is being sought through public and private funding sources.

DISCLAIMER

This is document is meant to stimulate discussion and create a platform from which to build a national earth science project. The ideas contained herein are being developed through an informal agreement between the CSIRO and Geoscience Australia, with additional and welcomed input from a variety of stakeholders. Any proposed work within this document is subject to contract and approvals in accordance with the Science And Industry Research Act, 1949. Neither organisation will be legally bound until these approvals are obtained.

VISION

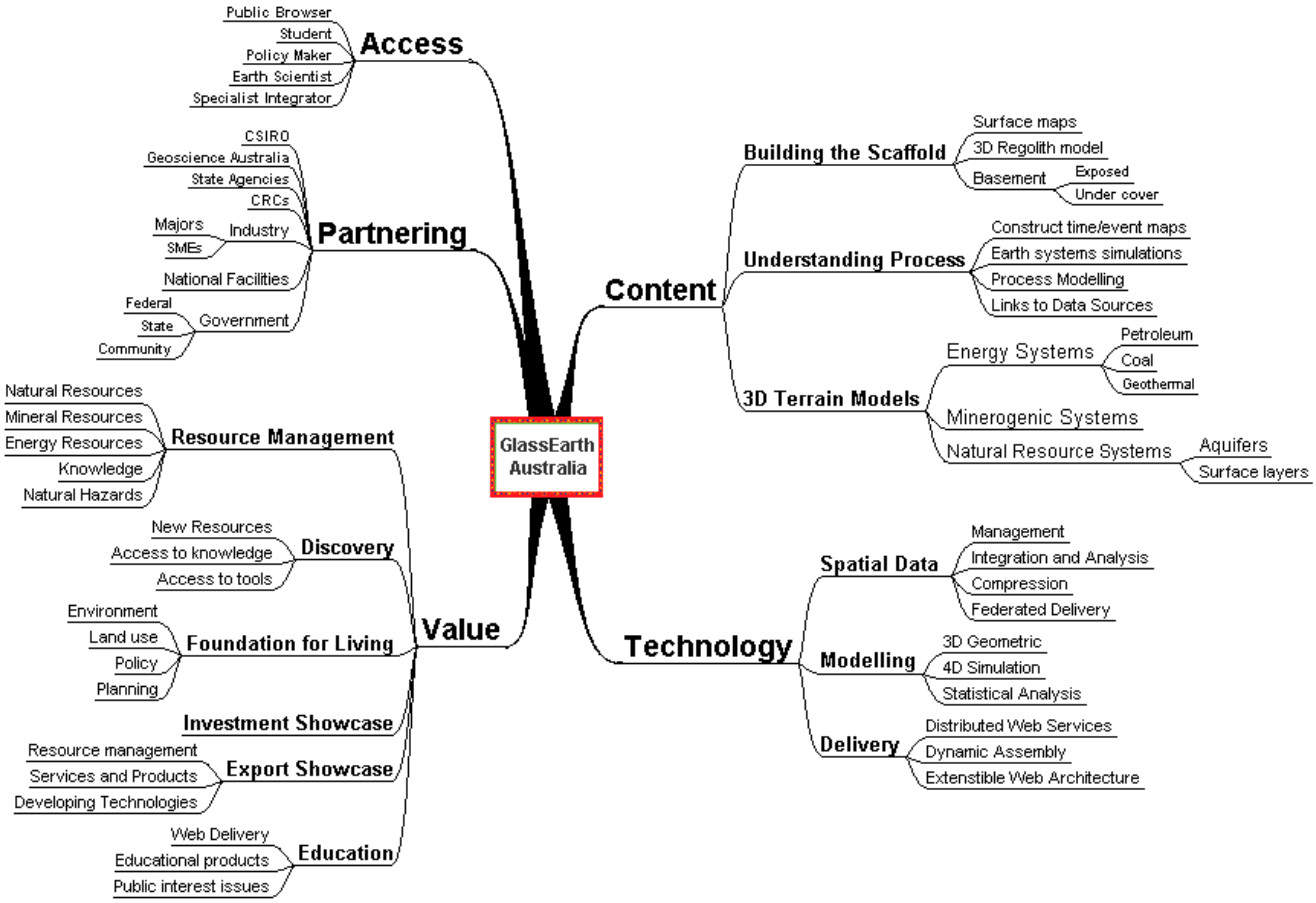
GlassEarth^{TM} Australia will provide a delivery vehicle in which to generate and capture knowledge about the earth under Australia that empowers the community, government and industry to sustainably increase our nation's wealth through discovery and management of its mineral, energy and natural resources.

GOALS

- Build and capture knowledge → **CONTENT**
- Optimise systems for capture, process and delivery → **TECHNOLOGY**
- Maximise the benefit to a wide range of users → **ACCESS**
- Increase knowledge flow for decision, discovery and management → **VALUE**
- Optimise effort → **PARTNERING**

THE PROJECT

Through a national consortium, with core partners CSIRO and Geoscience Australia, the objective is to build a knowledge-rich, spatial and temporal "digital map" of Australia which encapsulates our understanding of our natural, mineral, and energy resources and their genesis, and to deliver it through a highly visual, interactive and extensible web service, or "exploratorium", that provides multi-level user access to knowledge, information and data. A schematic outline of the project is shown below.



CONTENT

GlassEarth™ Australia must be accessible, interactive, queryable, and content-rich for geoscientists and non-geoscientists, alike. In particular, it must provide specific "knowledge-exploration" pathways for policy and decision makers, educators and students, and anyone interested in a sustainable Australia. This will be achieved via web delivery that combines the latest in visualization, dynamic assesmbly, extensible web architecture and interactive learning technologies.

The following tasks are envisaged to create and link content.

- ***Updating and revising the surface map.*** The principal task here is to agree on a map "style" that best suits the longer term 3D and 4D requirements, what are the principal architectural components and structures, and how best to attribute features for the 4D purpose. The architecture will build on current geographic information systems, and extend to include developing technologies within the international standards community.
- ***Constructing a time-space-event "chart".*** This will form the basis of the time dimension, and of the geological process attribution and interpretation. Even though we will build the present day 3D map first, it is essential to have the time intelligence built into the philosophy, methodology and GIS / metadata formulation from the beginning.
- ***Constructing the crustal / upper mantle "scaffolding".*** Populating the subsurface takes place by constructing cross sections, then linking the sections by major structures and boundaries to make a 3D scaffolding of surfaces, and finally by filling in volumes.
- ***Filling in the volume – building out from islands of detail.*** In the first stages, this will be accomplished by "dropping in" detailed volume information from specific areas. These will then form the building blocks and help to develop the technology and methodology for populating the whole volume. They will also form the detail for building the web services architecture.
- ***Building the 4th Dimension.*** Construction of event maps showing the dynamic evolution of the Australian continent in its plate tectonic environment. These will be linked to and integrated with the event history and structural time attribution above.
- ***Targeting terrains.*** This will target specific areas of national importance to Australia, creating models of the 3D geometric architecture and the processes operating therein. Examples of terrains include minerogenic provinces such as the Yilgarn in Western Australia, the Permian-age energy-producing basins of eastern Australia, or the Great Artesian basin. These integrated projects will build the detailed knowledge of resources.

TECHNOLOGY

GlassEarth™ Australia will build upon and link to the rich and exponentially increasing data and information sources in commonwealth and state government agencies, research bodies and the industry. This can be achieved through a web-services architecture for the earth and natural resource sciences that supports a loosely coupled distributed processing and data management architecture based on federated services assembled in a flexible configuration. This has the capability to transform earth and natural resource science information from a collection of isolated data repositories, applications and Web pages into an infrastructure of shared information and knowledge services. It will not just provide access to a rich suite of 2, 3 and 4-D information to a broad range of stakeholders. It will also provide these stakeholders with a broad range of tools to further process and enhance this information for their own specific needs.

The web services architecture is founded upon the "Spatial Data Infrastructure" model, itself a collation of best practice for implementing effective federated systems in similar organisational circumstances. This model must be expanded to account for the exponentially mounting volumes of data collected in the earth and natural resource sciences, as well as the move from 2D to 3D and 4D data and interpretive models. This move will require innovative methods for information architecture, data compression and visualisation across the web.

The implementation plan suggested is designed to deliver outcomes on a progressive basis, so that functionality and organisational capacity of data and knowledge providers can be developed in a realistic timeframe. This implementation strategy provides for immediate outcomes, minimal risks and maximum ongoing flexibility.

The approach draws on related activities within the broader technical environment to maximise the outcomes possible. National activities of note are:

- The Interoperability Framework for the Commonwealth Government (an initiative of the National Office for the Information Economy (NOIE))
- Australian Spatial Data Dictionary
- Australian Spatial Data Infrastructure Distribution Network - to provide a basis for cross jurisdictional technical standards
- CSIRO XMML project (leading to a possible "Geosciences Markup Language" with international status)
- National Land and Water Resource Audit
- West Australian Land Information System (WALIS)
- CANRI (NSW)

Many of the above national activities are in themselves subsets of broader global information frameworks including :

- Global Spatial Data Infrastructure
- The Open GIS Consortium (OGC)
- World Wide Web Consortium (W3C)

ACCESS

The aim of the Exploratorium is provide a multi-level user access portal to a mix of earth and natural resource science knowledge such as: communities, policy makers, earth scientists and specialist users. To achieve this the project must:

- Develop interactive learning pathways to data, information and knowledge about the earth and its resources;
- Deliver cost-effective online spatial applications in 2, 3 and 4D;
- Meet ongoing program needs in the sector;
- Enhance discovery of geosciences data and packaged information products;
- Be -able to download subsets of data for offline processing ("clearinghouse");
- Develop a capacity for facilitating on-line, interoperable access to earth and natural resource science data sets that are distributed throughout Australia
- Have interactive and batch spatial modelling functions
- Link to and from an expanding volume of geo-referenced documentation such as case studies, reports, action plans.

STRATEGIC PARTNERING

The consortium will build upon the strengths of its national and state agencies, cooperative research centres and major national research facilities and centres to ensure non-duplication of effort and maximum returns on investment.

The CSIRO currently invests in the Glass Earth initiative, that is a long term, national project to provide capabilities to "see into" the top kilometre of the earth and to understand the geological processes that lead to ore body formation within and beneath weathered and sedimentary cover. Within this initiative, technologies are being developed for enhanced geophysical and geochemical detection of ore bodies, novel forward simulation of complex geological processes leading to mineralisation, and the information and communications platforms that enable transparent access to knowledge and information. Geoscience Australia is the national agency for geoscience research and geospatial information, which contribute to enhanced economic, social and environmental benefits to the community by providing input for decisions that impact upon resource use, management of the environment, and the safety and well-being of Australians. Together, the integration and application of technology and knowledge underpin discovery, access and management within all of the resources sectors.

The consortium must also act in concert with State and Territory Geological Surveys, collaborative research centres (*predictive mineral discovery and Landscape Environment And Mineral Exploration), major national research facilities and centres, several leading SME's and the peak industry bodies (e.g. Minerals Council of Australia, Australian Institute of Mining and Minerals Engineering, Australian Petroleum Exploration Association), and leading Australian consultants. GlassEarth^{TM} Australia provides an extensbile vehicle with which to dock in and move forward.

VALUE

GlassEarth™ Australia will provide a rallying point for the industry, government agencies and research bodies to act in concert to improve our compliance and provide leadership in triple bottom line responsibility. The value lies not only in discovery of new deposits, but also in educating our people about the value of Australia and its resources.

GlassEarth™ Australia provides the capabilities to acquire, interpret and visualise new data that provide the geological knowledge to discover deposits currently undercover, both in brownfields and greenfields areas, and carry this knowledge into safe, efficient extraction and environmental management. In an environment of falling prices, Australia has increased its share of world output, suggesting that Australian miners are at the forefront of productivity growth and efficiency. However, the sustainability of this trend is in jeapordy if Australia's long-term reserves (>15 years) are not proven and replenished, or if Australia does not manage access according to the triple bottom line-environment, social acceptance and economic benefit.

GlassEarth™ Australia can provide an export showcase. We are a world leader in the provision of software, services and products to the global resources industries. It also demonstrates to the world that we value our pre-competetive knowledge base that resides within our commonwealth and state agencies. This knowledge base underpins the industry and access to it is critical for the future.

GlassEarth™ Australia provides an educational platform with potential spin-off products for all levels of stake-holders. The industry is "high tech", but has been unable to attract the brightest stars for the future, resulting in a talent shortage. CSIRO can take the lead in developing and promoting a new generation of data and knowledge management, and discovery through both the map and the exploratorium.

ALIGNMENT WITH NATIONAL RESEARCH PRIORITIES

In the establishment of the Prime Minister's National Research Priorities[i], the contribution of the earth resources sectors to Australia's national and regional economies was well recognised. Discovery and access to those resources, and their sustainable management are decision-making processes that require access to networked intelligence and knowledge – not just data and information.

The earth and natural sciences, which underpin our understanding of our resources, have traditionally used maps to capture and convey knowledge. As we delve deeper into the earth, we must be able to image, map and visualise from the surface through to target depths in 3 dimensions, both for discovery and for safe, and potentially remote extraction with minimal environmental disturbance. We must also be able to improve the probability of discovery success and predict the impact of

[i] Commonwealth of Australia 2002 (www.dest.gov.au/priorities)

changing the environment. This will rely not only upon smart, and high technology exploration methodologies, but also upon smart management, integration and interpretation of vast and disparate data sets. This can only be achieved through breakthrough science in geo-informatics, combined with a fundamental knowledge of the earth.

No such "map" exists for any country. GlassEarth™ Australia will set the standard, and the skills and technology developed in building the "map" will be eminently exportable. It will also provide a continuously enrichable and updatable receptacle for Australian geoscientific knowledge for at least a decade.

PROJECT DESIGN AND IMPLEMENTATION

A project of this scope and magnitude must be designed and implemented in stages to ensure stakeholder value capture.

STAGE 1 - DESIGN AND PROOF-OF-CONCEPT

6 months $750k

Stage 1 is designed to create a demonstration product that captures current knowledge about the Earth under Australia as a container for economic wealth. There are a number of existing projects that are developing 3D terrain models in different geological environments specific for gold, coal, base metals and salinity mapping. These terrain models will be integrated with more regional models being developed by Geoscience Australia and its partners in the CRC's. They will be visualised in the context of Australia and provide the nuclei from which to grow GlassEarth™ Australia.

During this phase the concept for the web service "exploratorium" will also be developed. The exploratorium must be able to engage the public through interactive learning pathways to understand the distribution of minerals, petroleum, coal, water and environment and their importance to Australia. It must also be able to enable decision makers within the community, government and industry through easy access to data, information and knowledge. Finally, it must provide extensible access to the earth scientists to generate new knowledge from disparate and distributed data and services

STAGE 2A – MAP CONSTRUCTION

3 years $5.3M.

Stage 2 is designed to create the content and implement web services. An estimate of required staffing is 20 people.

The cash requirements would be as follows.

[ii] Centre for International Economics (www.intecon.com.au). Minerals: Our Wealth Downunder. 1999.

[iii] Minerals Council of Australia (www.minerals.org.au). Minerals – Did You Know. 20 October 2002.

- 3-year appointments of research and geoscience staff to augment the in-kind staff. 6 staff required for map building and for interaction with / providing models to the Exploratorium. 2 or 3 of these would need to be "expert integrators", and the others could be smart juniors (possibly through post-doctoral program). Average cost (salary and on-costs only) of $100k each totalling $600k per year.
- Payments to expert consultants, casual contractors, and other research institutions. $1.0M per year – this is fully costed to include overheads.
- Technical and project management. Partly conducted by existing CSIRO and GA staff, but really needs new resources to ensure the best project management and quality assurance. $200k per year.
- IT hardware and software. $300k in Year 1, $100k in each of years 2 and 3.
- Travel and miscellaneous. $200k per year.

STAGE 2B - BUILD THE WEB-SERVICES ARCHITECTURE
1.5 Year $1.5M

Based on stakeholder consultation, prototypes will be designed to demonstrate available functionality and to gather feedback on opportunities and priorities. At this point it should become possible to sign up partners and move towards a complete application. There is a close relationship between technical architecture, organisational arrangements and funding models, but the best available strategic thinking and practical expertise should be actively sought across all these issues to ensure that the project has the best platform for ongoing successful operations.

Implementation planning will need to take careful note of:

- Planned and actual progress of uptake by stakeholders
- Development of capacity to respond to external opportunities
- Ongoing evolution of technical standards
- Support for development of common semantic frameworks through typical cycles of harmonisation and specialisation
- Ongoing communications requirements
- Process to modify or introduce new technologies, methodologies, services, stakeholders etc

STAGE 3 – IMPLEMENT AND MONITOR WEB SERVICES
1 Year $3M

This stage would see the technical implementation of any specific infrastructure capabilities determined by the business analysis. It is envisaged that these would include:

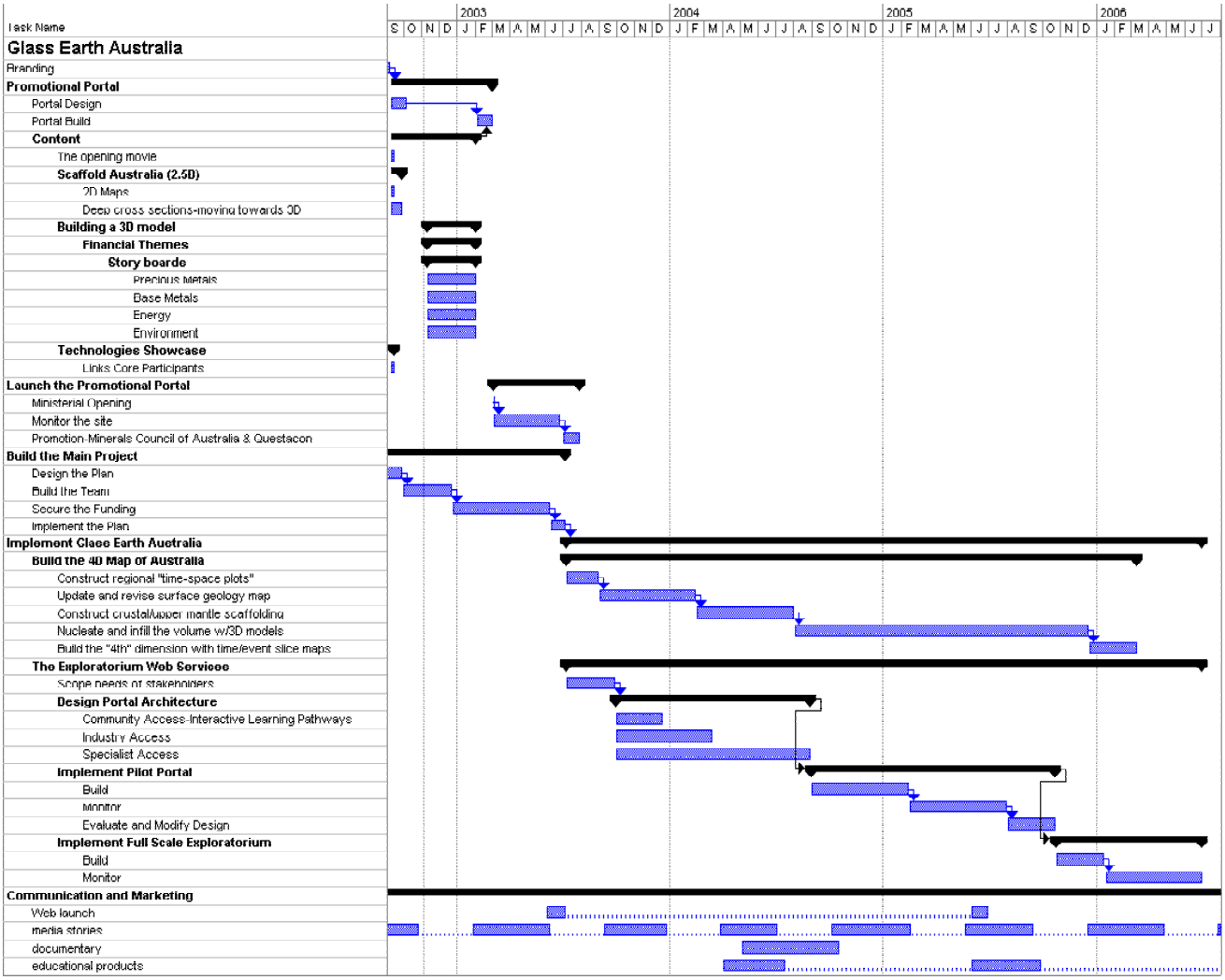
- Data publishing processes and tools to support this
- Metadata catalogues – data design and integration
- Controlled vocabulary services (management, searching)

- Integration with key shared services

The developed capabilities made available to stakeholders will be monitored and modified against usage patterns identified by stakeholders.

PHASE 4 - SUSTAINABILITY AND GROWTH
1 Year $1M

The GlassEarth™ Australia will need to be designed to evolve and grow, encompassing more of the existing resources, encouraging new approaches and empowering process change to adress the chaning needs of the earth and natural resource sciences information management. Careful analysis, ongoing review and systematic testing of processes to maintain and grow such a system are all likely to be required.



SUMMARY STATEMENT

Australia is well placed to achieve the sustainable management and development of our resources. We have large, technologically advanced and generally strong minerals, energy and natural resources industries, we are leaders in the provision of software, services and products to the global resources industries, and our professional skills and R&D base for these industries remains strong despite recent erosion.

However, we have approached the issues of sustainable development from a fragmented base (WCP, 2001). Data, information and knowledge reside in disparate factions and there is no mechanism to capture and integrate this wealth of knowledge so that the industry, the public and the policy makers can make balanced decisions for our future. There is a gulf between the data / information-rich science and industry base and the accessible, knowledge-rich translation of that science to the non-specialist users who are our present and future decision-makers. Put simply, the scientists, technologists and practitioners have failed to transfer their knowledge to the broad constituency of sustainable development with the clarity, accessibility, passion and engagement that genuinely empowers that constituency to make the best decisions for future generations.

Policy makers, educators, students, consumers and concerned citizens deserve a rich, vibrant and accessible canvass of answers to their questions and concerns, and the wherewithal to assess the risks and uncertainties associated with any decision. Sustainability is a complex issues at all levels from the scientific to the political. The GlassEarth^{TM} Australia project can lead the way to develop this canvass and deliver a key component of the scientific foundation for addressing these issues – a clear picture of the earth beneath Australia, presented in a highly visual, interactive, content-rich, “exploratorium” designed to engage, integrate and inform the broadest possible constituency.