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The Design and Implementation of the Australian Geothermal Reporting Code—A World First Standard Reporting Code for Geothermal Reserves and Resources

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ABSTRACT

This paper will describe the development and implementation of the Australian Geothermal Reporting Code (the “Geothermal Code” or the “Code”) and will give an overview of the Code itself. The Code is the world’s first standardized reporting code for exploration results and estimates of geothermal reserves and resources and may form the basis for an international reporting methodology which in turn may free up cross border capital.

The Code was developed through 2007-08 by a committee of company, technical and regulatory stakeholders, jointly sponsored by the Australian Geothermal Energy Association (AGEA) and the Australian Geothermal Energy Group (AGEG). A number of models from the energy and minerals sectors were considered but the Australian minerals reporting code was found to be both adaptable and acceptable to regulators and formed the basis of the new Geothermal Code. The Code was launched in August 2008 and its use is mandatory for stock-exchange listed members of AGEA when making Public Reports to the market involving Geothermal Reserves, Resources and Exploration Results.

The Geothermal Code seeks to regulate and standardize the way companies present relevant reports to the market by making them transparent, material and competently compiled. It does not seek to regulate or standardize the way technical persons compute or estimate those quantities or results, although some conventional methodologies are suggested and significant deviations from these methodologies need to be noted when making a report under the Geothermal Code.

Geothermal Resources may be classified as Inferred, Indicated or Measured, in order from lowest to highest technical confidence as judged by the Competent Person. After consideration of Modifying Factors including demonstrating the likelihood of economic extraction of the geothermal energy, Indicated or Measured Resources may be converted to Probable or Proven Geothermal Reserves respectively.

Although developed primarily for Public Reporting of stock-exchange listed companies, the Geothermal Code has wider potential. If an international version was adopted, it would allow financiers and investors a standard platform to comparatively value any company with geothermal reserves or resources and hence allow a freer flow of cross border capital.

History and Background

Australia has long had an active capital market supporting the mining and energy sectors and resources companies account for a significant proportion of the market capitalization of companies listed on the Australian Securities Exchange (ASX). The Listing Rules of the ASX have developed alongside these traditional resources sectors to bring about a Public Reporting regime in which both investors and regulators have confidence in the consistency of terminologies and mechanisms of accountability. This has created a platform by which a company’s long term value adding resource assets can be stated in a consistent way and hence compared by investors and lenders, and has greatly facilitated the raising of both debt and equity.

Specifically, the Listing Rules of the ASX incorporate aspects of the Society of Petroleum Engineers (SPE) regime and, for the mining sector, the entire Joint Ore Reserves Committee (JORC) Code. The JORC Code governs how Australian publicly listed mining and exploration companies may make Public Reports concerning their Exploration Results, Mineral Resources and Ore Reserves. The Listing Rules of the ASX are regulated by the Australian Securities and Investment Commission (ASIC) and therefore have the force of federal law.

The Australian geothermal sector has expanded rapidly in the past decade, consisting now of some 11 stock exchange listed and approximately 30 unlisted companies. These companies are targeting Engineered Geothermal Systems, Hot Sedimentary Aquifer and/or ‘Direct Use’ type geothermal plays within Australia and some are also looking at these and ‘conventional’ geothermal plays outside of Australia.
By 2007, several companies had reached the stage where the need for formal estimation of geothermal resources was approaching and a mechanism was required to have those estimates reported to the market in an acceptable manner. In 2007 a group was formed comprising stakeholders from companies, regulators and technical agencies to produce a Code to regulate Public Reporting by geothermal companies in Australia. This group is now constituted as a committee under the technical umbrella group the Australian Geothermal Energy Group and the company policy & lobby group, the Australian Geothermal Energy Association.

**Development of the Geothermal Reporting Code and the Geothermal Lexicon**

After considering a number of models, the ‘Geothermal Code Committee’ chose to base the new Australian Geothermal Reporting Code on the JORC mineral code model, for four main reasons:

- It had been developed and revised for more than 20 years and found to be very robust;
- Australian regulators were accepting of it;
- Mineral sector investors around the world were familiar with it and it has been formally accepted for use in some overseas jurisdictions; and
- It was desirable to minimize the introduction of new terminologies and concepts.

A code based on hydrocarbon reporting, such as the SPE regime could have been adopted but it was considered that it was less well known in Australia and probably too complex and difficult to adapt to the particular circumstances facing the industry in Australia at the time.

The scope of the new Geothermal Code was uniquely designed to accommodate all forms of geothermal energy, including ‘conventional’ geothermal plays. Geothermal heat pump operations are not included in the Code for a number of reasons, including the lack of ability to obtain a tenement and therefore ownership over the ‘resource’.

During 2008 the Geothermal Code Committee met to resolve many issues arising in the adaptation of a minerals reporting code to the geothermal environment, whilst preserving the key terms and principles. One of the key determinations was in respect of reportable energy units, as follows:

- Thermal energy in place in Petajoules for Inferred Resources;
- The same for Indicated and Measured Resources, optionally also as recoverable thermal energy in Petajoules. These categories may also be reported as assumed electricity generation and rates as MW\text{e} for a defined period or GWh in total;
- Probable and Proven Reserves are reported as thermal energy in place and recoverable thermal energy (Petajoules). Electricity generation should be presented as net electricity output (MW\text{e}) for a defined period or GWh in total.

In all cases all key assumptions should be stated alongside the energy totals and in the case of electricity generation figures, a statement on the technological pathway proposed for the energy extraction/conversion.

Another issue that called for additional consideration was the definition of the lowest confidence category, Inferred Resources. Given the high cost of drilling test wells into a reservoir, it was decided that, to allow junior companies to report early stage reservoir definition in a controlled manner, an Inferred Resource could be estimated and reported without any direct well penetration into the reservoir.

The Code governs how exploration results and geothermal resources and reserves are publically reported, but not the method of computation or estimation. In fact the Code deliberately refrains from prescribing methods of estimation. However, as the sector was new in Australia, the Committee decided also to compile a Geothermal Lexicon which would describe good practice in estimation methodology. The Lexicon is not required to be used under the Code, but if the methodologies outlined in it are not broadly followed, then this must be stated in the Public Report.

**Implementation of the Code**

The *Geothermal Reporting Code 2008 Edition* was launched in August 2008 at the first Australian Geothermal Energy Conference and was adopted as mandatory for AGEA members for a six month trial. The Geothermal Code Committee established a Compliance sub-committee which periodically reviewed Public Reports made by AGEA members and then offered confidential feedback to those companies. A number of Practice Notes were also compiled and circulated by the Geothermal Code Committee to inform AGEA members on ‘best reporting practice’ in respect of particular aspects of the Geothermal Code.

The trial period identified several issues but none which rendered the continued application of the Geothermal Code impracticable. Therefore use of the Code remains mandatory for AGEA companies when making Public Reports.

The main issues that have been identified in the early application of the Geothermal Code include the following:

- Generation and reporting of large Inferred Resource figures which have the potential to mislead if the confidence level of the estimation is not understood by the reader. This issue comes about through the definition not requiring a direct penetration of the reservoir, allowing the energy in place of large volumes of reservoir to be reported and also because recovery factors and conversion efficiencies are not required to be made. This issue will likely be mitigated by the eventual requirement to apply a plausible recovery and conversion factors to the raw Inferred Resource figure(s). In combination, these could reduce the reportable figure to as little as 1% of the energy in place.
- Lack of understanding by companies of the role of the Competent Person in the drafting and sign-off of various types of Public Reports, such as derivative summaries of reserves and resources as might appear in Annual or Quarterly Reports. The answer here found in the Code is that each and every report of data involving a Competent Person’s estimation of Resources, Reserves or exploration results must be agreed to in writing by the Competent Person.
The amount of technical detail required in Public Reports; some reports have been very brief whilst some companies released the entire original internal technical report on the resource estimation. Ultimately it is up to the Competent Person to agree to the content of any Public Report based on their work. A very brief report will likely not contain enough information to allow the confidence on the ‘bottom line’ figure to be assessed, while a full report is unlikely to be comprehended by the target audience of investors. In early reports, as an education exercise, the Geothermal Code Committee has suggested more information is better than less, and a resources or reserve report of between 10 and 20 pages would be adequate, with the length of report probably decreasing over time.

The Geothermal Code has been disseminated to organizations and experts around the world and feedback has been constructive and positive. A number of comments or queries have come from technical persons concerned with the possibility of their technical freedom being restricted or bringing up particular circumstances where there is ambiguity with data or interpretation, for instance which temperature(s) in and around a reservoir should be used. In nearly all cases it can be shown that the Geothermal Reporting Code in no way limits any estimation methodology or choice of data, as long as those choices are clearly stated in the Public Report and can be justified by the Competent Person, if called upon to do so.

The Competent Person must also make judgments as to the classification of the resources and/or reserves. Again, there are no ‘rules’ laid out but check-lists and prompts are given in the guidelines and at the end of the day, the experience of the Competent Person is relied upon, as is their preparedness to defend their choices.

In discussing and reporting geothermal reserves and resources, the term ‘estimation’ is preferred over terms such as ‘measurement’ to emphasize that the computation is not exact.

From the use and discussion in Australia and internationally, a number of improvements in the Geothermal Code have been identified and a Second Edition of the Code is scheduled for November 2009. The Geothermal Code is stated to be a ‘living document’ and changes are expected into the future.

Following the successful trial, AGEA has begun the process of having the Second Edition formally incorporated into the ASX Listing Rules which in turn will bring about mandatory compliance under federal law. This process will take at least a year.

**International Geothermal Reporting Code Harmonization**

The Australian Geothermal Code Committee has taken the view that there is value in consistency of principles, terminology and frameworks across the international resources sector. The Geothermal Code aligns with the JORC Code which in turn conforms to the international CRIRSCO (Committee for Mineral Reserves International Reporting Standards) template.

Although primarily a tool for the protection of small investors on public markets (in the case of Australia), codes with international recognition such as SPE and JORC free up cross border capital by allowing the resource and reserve assets of a company in one jurisdiction to be easily assessed and valued on a standard template by public or private investors anywhere in the world.

It is hoped that in co-operation with other national geothermal organizations, the Geothermal Reporting Code might form the basis of a uniform, or at least a harmonized international geothermal reporting code, which will greatly assist cross-border investment and understanding.

**Key Elements of the Geothermal Reporting Code**

The Code seeks to govern how Public Reports of stock-exchange listed companies are worded and presented. It does not govern how resources and reserves are estimated, although if methodologies deviate significantly from the conventional techniques outlined in the Geothermal Lexicon, then that must be stated and able to be defended.

The Geothermal Code document includes some guidelines in italics to provide assistance and guidance to users. They do not form part of the Geothermal Code but should be considered persuasive when interpreting it.

The governing principles of the Geothermal Code are:

a) **Transparency.** This requires that the reader of any Public Report is provided with sufficient information, clearly and unambiguously presented, to understand the report and not be misled;

b) **Materiality.** This requires that a Public Report contains all the relevant information which investors and their professional advisors would reasonably require, and reasonably expect to find in the report, for the purpose of making a reasoned and balanced judgment regarding the material being reported; and

c) **Competence.** This requires that the Public Report be based on work that is the responsibility of suitably qualified and experienced persons who are members of recognized, relevant professional organizations and subject to accountability and a professional Code of Ethics.

Under the Code, the writer or compiler of a technical report on either geothermal exploration results, or the estimation of geothermal resources or reserves must be a ‘Competent Person’ (CP), who is defined as having at least five years of relevant experience in the type of geothermal play under consideration. If a company then wishes to make a Public Report based on that work (for instance, quoting the Resources or Reserve figures), the CP concerned must be satisfied as to the form and content of the Public Report as it relates to their work and then must consent in writing to be personally identified as such in the Public Report. This places a dual onus on the reporting company and the CP to produce a Public Report that is transparent, material, competent and defendable.

The company is accountable, currently to the Australian Geothermal Energy Association but eventually to the Australian Securities Exchange and to Australian Federal Law, and the Competent Person is accountable to their professional organization and its code of ethics.
Resource and Reserve Relationships and Categories

The relationship between Exploration Results, Geothermal Resources and Geothermal Reserves under the Code is illustrated in Figure 1:

<table>
<thead>
<tr>
<th>Exploration Results</th>
<th>Geothermal Resources</th>
<th>Geothermal Reserves</th>
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<tbody>
<tr>
<td></td>
<td>Inferred</td>
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<tr>
<td></td>
<td>Indicated</td>
<td>Probable</td>
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<td></td>
<td>Measured</td>
<td>Proven</td>
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Figure 1. Relationship between Exploration Results, Geothermal Resources and Geothermal Reserves.

Inferred Geothermal Resources may be estimated using parameters measured external to the actual reservoir, for instance heat flows in bore holes above the reservoir and porosities, permeabilities and other rock characteristics of laterally equivalent or analogous formations. This latitude was allowed to enable junior companies to have some ability to state their early asset base in a controlled manner, recognizing that this is the first step in them raising capital for the usually expensive deep drilling required to properly test a reservoir.

With increasing levels of technical knowledge and confidence (for instance, initial and then increased density of drilling, longer and more detailed well testing), geothermal resources progress from Inferred to Indicated and then to Measured. These categories are mutually exclusive and the sum of them all equates to ‘total Geothermal Resources’. There is no explicit claim of the ability to economically extract any of the estimated Resources at the time of reporting (i.e. for electricity production or ‘direct use’). However, the Code states that there should be “reasonable prospects for eventual economic extraction”, to avoid the meaningless summation of all conceivable geothermal energy in a volume.

If studies into energy recovery and conversion, economic, marketing, legal and other factors are undertaken, so as to demonstrate energy extraction at a profit, then Indicated Resources may be converted into Probable Reserves and Measured Resources may be converted into Proven Reserves. The level of knowledge regarding Inferred Resources is always such that they may never convert directly into Reserves. Reserves may fall back to Resource status if the economics of the project decline. Again, Proven and Probable Reserves are separate quantities and their sum equates to ‘total Geothermal Reserves’. The Reserve quantity may include that part of the Resource modified to produce the Reserve, so any statement of Reserves must clearly state whether stated Resources are additional to, or included in the Reserve quantity.

As the economics of a particular geothermal play are heavily dependent on the technology used to deliver the energy to market, any statement of Resources or Reserves must clearly state the technological path-way considered in the particular estimation, together with any critical assumptions including the expected market, recognizing that energy prices are site specific. It is not necessary for a Public Report to supply all the information required to duplicate the estimation, but a technically informed person should be able to recognize any gross flaws in the estimation process from the information supplied.

Summary

The rapid growth of the Australian geothermal sector, particularly in the public markets has driven the development and implementation of the world’s first Reporting Code for Geothermal Exploration Results, Resources and Reserves. The Code is based on the principles of transparency, materiality and confidence and places responsibility on both the reporting company and the Competent Person to ensure these criteria are met. The Code classifies Resources according to the level of geological knowledge and confidence. Reserves are those parts of Resources from which the energy can be extracted at a profit under the commercial, social and regulatory regime prevailing at the time of extraction.

The Code regulates the form and wording of Public Reports on estimated quantities but does not limit the technical person’s scope or flexibility in the actual estimation process.

The Code was implemented in 2008 and since that time has operated successfully, although changes in respect of a number of features are likely to appear in the Second Edition, due in November 2009.

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References

