1 Introduction

NUMO is responsible for the siting, development and operation of a deep geological repository for high level waste (HLW) in Japan. The process is expected to take at least 15 years to reach the point of repository construction. During the period before this, NUMO will need to evaluate sites that emerge from the ‘volunteer process’ (whereby local communities have been invited to volunteer to be considered as potential hosts for the repository) and select a preferred site. This evaluation will involve initially surface based and then underground site characterisation work. Underground characterisation work will only take place at the preferred site. Prior to the surface based investigations, volunteer sites will have first had to pass a test of general suitability and NUMO will then have carried out a detailed, literature-based preliminary evaluation of suitability, prior to accepting them as ‘Preliminary Investigation Areas’ (PIAs). Because Japan lies in such a tectonically active region of the world on the Pacific rim (the so called ‘ring of fire’), a key aspect of all these steps is consideration of the susceptibility of a site to future tectonic activity and tectonically driven processes and events.

In particular, the potential for volcanic and rock deformation impacts on a repository site needs to be considered at each stage of NUMO’s siting programme. Whilst the nationwide evaluation factors for qualification (EFQs) for PIA acceptance are designed to remove clearly unsuitable sites from consideration, they cannot guarantee that, over the next tens of thousands of years, the risks of tectonic hazard for a chosen PIA will be acceptable. This is because large parts of Japan that are potentially suitable for siting are directly affected to varying extents by rock deformation, the peripheral impacts of volcanic activity or the possibility of new magma intrusion or volcanic activity. The EFQs were only intended as a ‘blunt instrument’ to prevent obviously poor candidates entering the siting process.

Consequently, additional ‘sharper’ and more refined techniques are required to evaluate sites that pass the EFQ test, so that NUMO can have a clear idea of the likelihood and potential impacts of tectonic events and processes at each PIA. The ITM project[1] has been designed to provide NUMO with such a methodology, based upon state-of-the-art approaches used internationally, developed and extended for the specific purposes of NUMO and the specific conditions of Japan: hereafter, we refer to it as the **‘ITM Methodology’**.

The ITM methodology is essentially probabilistic in nature. A probabilistic approach is seen by the ITM expert group as the only realistic means of addressing the uncertainties in predicting possible hazards when there is marked variability in the spatial distribution, the timing, the intensity and the style of the volcanic and deformational events and processes being evaluated. The probabilistic approach being developed is based upon and strongly supported by deterministic models of the underlying tectonic processes that lead to magma intrusion, volcanism and rock deformation.

NUMO is developing both the probabilistic ITM methodology and other, independent, deterministic approaches, in parallel projects which will eventually be deployed at volunteer sites when they arise. The weight that will be given to deterministic and probabilistic evaluation results will depend, to some extent, on the nature and the geographical location of these sites.

The probabilistic ITM methodology is able to be used at three important stages of NUMO’s siting programme:

- STAGE 1: during the literature survey (LS) stage when potential PIAs are being assessed. The ITM methodology will use currently available information to allow

[1] The ITM project was started by taking a recommendation in the second International Tectonics Meeting in 2004 that NUMO should prepare a probabilistic methodology as well as deterministic ones which will mainly be employed in site evaluation.

comparison of sites in terms of confidence that they are likely to prove acceptable with respect to tectonic impacts.

- STAGE 2: during the planning of the PIA site investigations, to identify geoscientific information requirements that will be needed to refine the Stage 1 analysis.

- STAGE 3: at the point where PIAs are being evaluated and compared in order to select a preferred site (or sites) for detailed investigation (as DIAs).

The ITM project is mainly concerned with Stages 1 and 2. Application of the methodology in Siting Stage 3 is several years into the future and it is expected that it will be most efficient to carry out any necessary updates/refinements on a region-specific basis during the PIA investigations when NUMO has narrowed down to a group of sites. The ITM project involves methodology development and testing only and does not include actual deployment for volunteer sites/regions.

The overall structure of the ITM methodology is described in Chapman et al. (2009 in press) and consists of:

- assembling nationally available data and alternative models of the nature, causes and locations of tectonic processes and events;

- using probabilistic techniques to evaluate the likelihood and scale of future tectonic processes and events, shown as a function of their type and geographical distribution;

- feeding information on these potential likelihoods and impacts to NUMO's performance assessment team so that feedback can be provided on repository performance under tectonic stress;

- providing clearly justified and traceable input to decision-making on consequent site suitability.

For convenience, the methodology for rock deformation and volcanic hazards assessment has been applied as two parallel tasks. This recognises the fact that, although the concept of each approach as shown above is similar, in some parts of the methodology they differ significantly in detail. Consequently, it was found that two teams with different specialities (structural, geophysics and tectonics specialists; volcanologists) worked efficiently in parallel. However, it is most important that, if carried out in this manner in future, the two 'discipline' teams integrate their work frequently (more so than has been possible in this development project) as there are clear overlaps in the processes being evaluated (e.g. magma intrusion has an impact on rock stress regimes and vice versa). NUMO will need to ensure that such integration is carried out effectively when the methodology is applied to 'real' sites.

The broad structure presented above is shown in more detail in the top-level methodology 'road-map' in Figure 1.1. It comprises a series of eight Steps, distinguishing in the early Steps between the 'rock deformation' evaluation and the 'volcanic' evaluation, where they involve significantly different activities.

This Report covers the final results of a Case Study designed both to help develop and then to test the ITM Methodology. The Case Study was carried out using information about the Tohoku region of northern Honshu. This area was selected for the study as it is the centre of current discussions about the varied strain response of the crustal plate to subduction of the Pacific Ocean plate (the key current tectonic driver for much of Japan) and about the mechanisms that underlie the apparent clustering of Quaternary volcanoes in much of Honshu. A second Case Study is adapting the ITM methodology developed in the Tohoku area for examining the very different tectonic situation of Western Japan – Kyushu, and the results of this work will be reported separately.

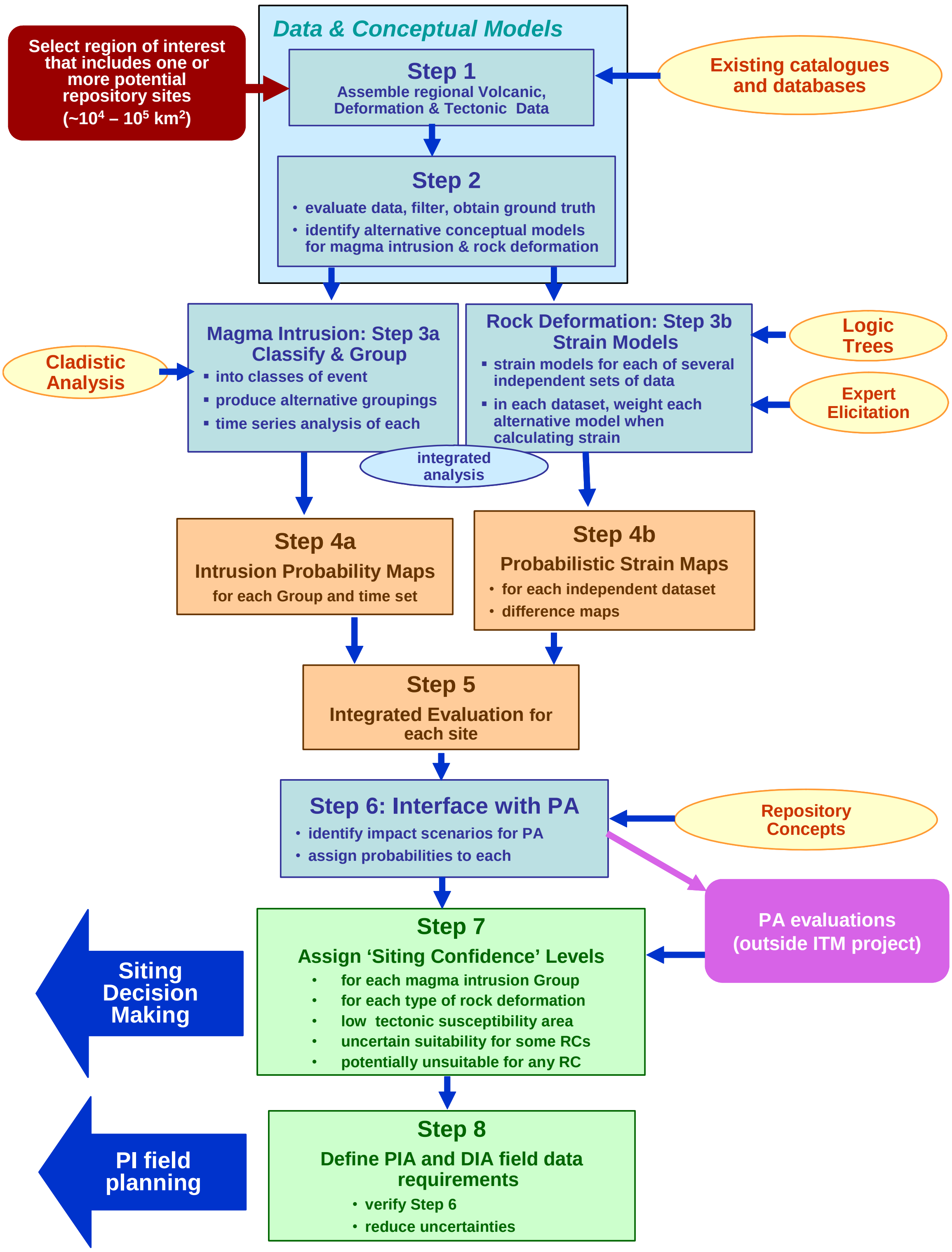

Figure 1.1: The Steps in the ITM methodology, shown as a top-level road-map.