Borehole Depths

Description: One method by which the integrity of an underground store or repository may be compromised is by inadvertent penetration by a borehole drilled from the ground surface or from underground. This 'human intrusion' scenario has been considered in performance assessments e.g. JNC [2000] and Nirex [2003]. The probability that this event will happen depends on many factors such as:

- retention of knowledge of the repository,
- assumptions about technological capability of future communities,
- the presence of potential economic resources in the vicinity or below the repository and its contaminant plume,
- the extent to which the repository creates a geothermal, geochemical or geophysical signature that could be mistaken for an economic resource, and
- most importantly, the depth of the underground facility.

Limited data on the frequency of borehole terminal depths have been reported for parts of the United Kingdom (Jowett & Chapma, 1987; Billington, 1992) and from Japan (JNC, 2000). These have been derived in the context of a deep repository and have either considered only certain types of exploration activity and / or have ignored boreholes with shallow terminal depths, variously interpreted as less than 50 or 100 m.

Figure 1 shows the results used in the H-12 assessment (JNC, 2000) based on data from Niizuma (1982). It clearly shows a sharp reduction in borehole frequency with increased terminal depth. The low frequency for boreholes less than 500 m deep is probably due to the limitation of the data to 'resource exploration' boreholes only. Terminal depth data for 879,761 boreholes drilled on land in the United Kingdom, except Northern Ireland, and held by the British Geological Survey [BGS, 2003] are shown in Figure 2. For clarity the figure excludes 847,655 boreholes with terminal depths less than 100 m. This confirms the rapid fall in borehole frequency with increasing depth. Note that in the UK dataset 96.4% of boreholes are less than 100 m deep.

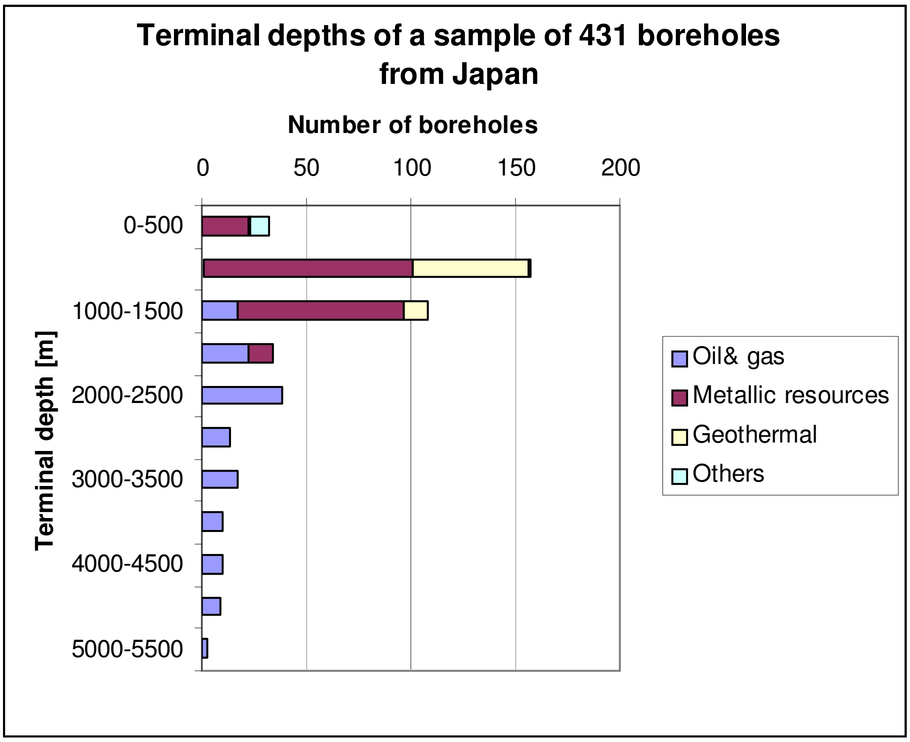

Figure 1 Terminal depth frequency data for a sample of Japanese deep boreholes. Data from Niizuma [1982].

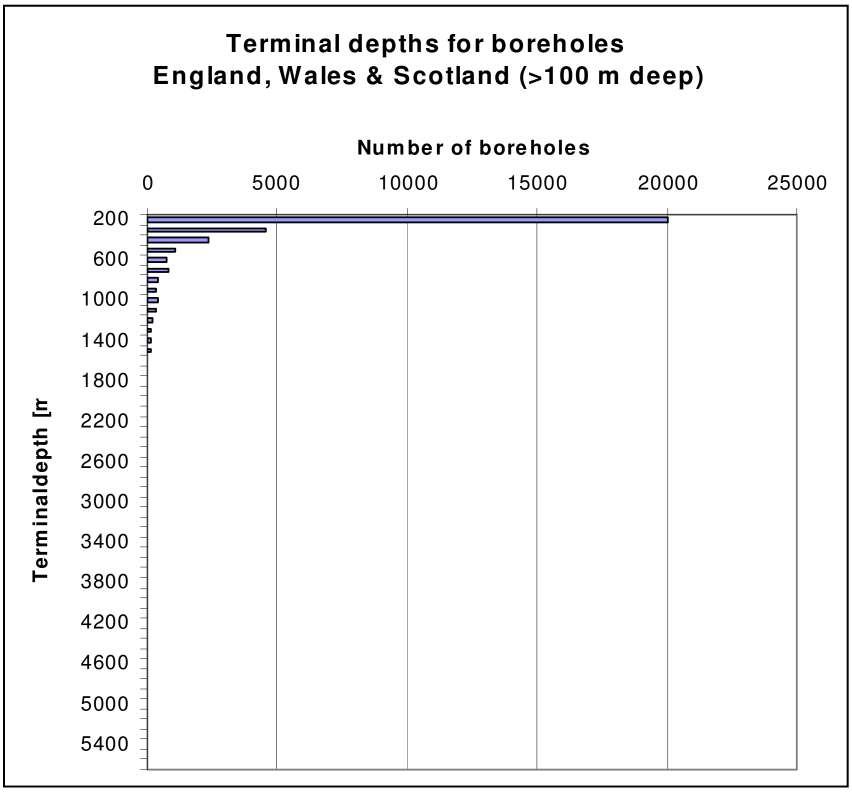

Figure 2 Terminal depth frequency data all boreholes >100 m deep drilled in England, Wales and Scotland and held in the BGS database [BGS, 2003].

Details of frequency distributions will be specific to each region but both distributions show that:

- There is a dramatic decrease in number of boreholes with increasing depth. Therefore the deeper a store / repository is constructed the less likely that it will be penetrated by a borehole drilled without knowledge of the existence of the repository / store.

- The vast majority of boreholes are drilled to less than 100 m depth so facilities at these depths are particularly likely to be penetrated by drilling. They would also be subject to disruption by surface excavation, tunnelling and quarrying activities.

***Relevance*:** These types of studies are relevant to discussions on the merits of shallow versus deep stores or repositories. They can be used to parameterise the probability of a drilling human intrusion scenario.

Position(s) in the matrix tables: Not applicable.

***Limitations*:** Any such frequency data must be site dependent. Extrapolation to the future has to make assumptions about future drilling technologies, geoscience knowledge and what may drive future deep drilling.

***Quantitative informatio*n:** Drilling frequency data can be abstracted from such studies.

***Uncertainties*:** The completeness or otherwise of the borehole data base is a key uncertainty.

***Time-scale*:** The analogue covers the human time-scale (0-100 years).

PA/safety case applications: See for example JNC's H-12 (JNC, 2000) and Nirex's GPA (Nirex, 2003) performance assessments.

Communication applications: None known.

***References*:**

BGS. 2003. Geoscience data Index – Borehole map theme. Downloaded from http://www.bgs.ac.uk/geoindex/boreholes.htm Accessed May 2003.

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Reviewer: Les Knight, Nirex (October, 2003).