In-situ Stresses in Icelandic rock mass
Summary of rock stress measurements

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Background
Several rock stress measurements have been performed in Iceland during the last decades (Figure 1a, Table 1). An example of a results from stress measurements is shown in Figure 2. The aim of the study presented here is to compile those measurements to create a summary available at one place.

Importance of knowledge
Rock stresses have impact on rock mass behaviour during tunnelling. High or low horizontal stresses can cause spalling along the tunnel perimeter (Figure 3a). Their magnitude is further important when:

- Creating realist computer models of underground structures.
- Emulate real conditions already in the design process.
- Determining stability, deformations and need for reinforcement (figure 3b).
- Creating reliable time and cost estimate.

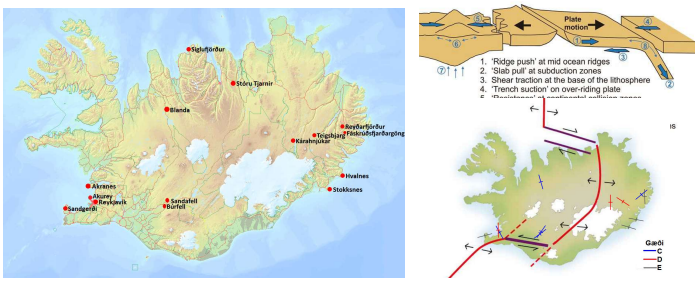

Figure 1: a) Location of rock stress measurements in Iceland; b) continental drift; c) Volcanic rift zones in Iceland.

Table 1: Rock stress measurements in Iceland.

Year	Place	Method*	No. of measuremtns	Depth [m]
1966	Siglufjörður**	OC	-	-
1967	Búrfell HEP	OC	7	75
1968	Hvalnes	OC	1	29
1968	Stokksnes	OC	1	30
1968	Akurey	OC	3	3 – 13
1968	Sandgerði	OC	1	4
1977	Reykjavík	HF	7	180 – 375
1979	Akranes	HF	1	100
1979	Blanda HEP	HF	5	100 – 170
1979	Stóru Tjarnir	HF	1	100
1981	Reyðarfjörður	HF	24	52 – 576
1981	Sandafell	HF	5	134 – 149
1981	Teigsbjarg	HF	7	25 – 504
1998	Kárahnjúkar	HF	13	40 – 163
1998	Teigsbjarg	HF	13	155 – 412
2004	Fáskrúðsfjörður tunnel	OC	47	100 – 955
2005	Fljótsdalur HEP	OC	26	500

** OC = Overcoring, HF = Hydraulic fracturing test*
*** Information not reliable*

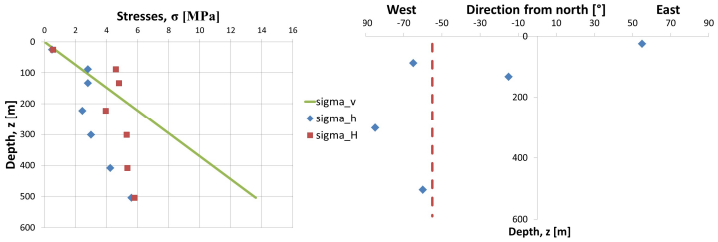

Figure 2: Typical results from rock stress measurements in Iceland taken from Teigsbjarg. a) min and max horizontal stresses and vertical stresses; b) the direction of the maximum horizontal stress and the average direction (dotted line).

Figure 3: High rock stresses in
a) weak rock results in great deformations (figure left).
b) hard rock results in spalling and/or rockburst (figure right).

k-value
The k-value describes the relationship between mean horizontal and vertical stresses: $k = {}^{\sigma_{hor}}/_{\sigma_v}$
Sheorey (1994) developed a approximation for the k-value as a function of the deformation modulus, E_h and depth z:

$$k = 0{,}25 + 7E_h\left[0{,}001 + \frac{1}{z}\right]$$

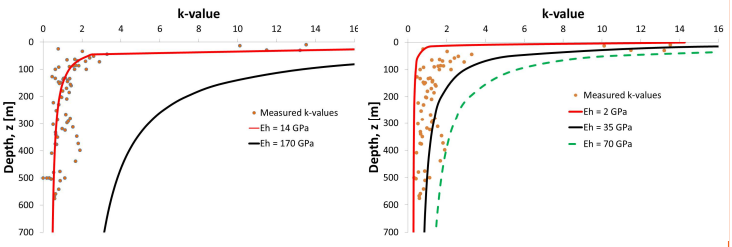

Figure 4: Measured k-values in Iceland. a) Upper and lower limit for k-values worldwide; b) Limits adapted to the Icelandic conditions.

Conclusion
Horizontal stresses in Iceland are very low compared to other places in the world which results in low k-values. The main reason is the tectonic plate movement. Iceland is on the North American and Eurasian plates which are moving apart from each other.

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