Geoscientific Studies in MIU Project-Relation between in situ stress and geological condition

Atsuo Yamada[1]; Toshinori Sato[1]; Shigeo Nakama[1]; Harumi Kato[2]

[1] JNC Tono; [2] Geotechnos Co.,LTD, Geoscience Consulting Division

http://www.jnc.go.jp/ztounou/miu_e/index.html

1. Introduction

The goals of the rock mechanical investigations during the surface-based investigation phase are to define the mechanical properties and in situ stress state to about 1,000 metres below ground level in the Toki granite for input to the design and construction of the underground facilities, and to develop a methodology and a conceptual model of rock mechanics on a gallery scale model.

Investigation items are in situ stress measurements by hydraulic fracturing test and core-testing methods, laboratory tests on physical and mechanical properties.

Deformation and stress changes in the rock mass around the shafts and galleries and the extent of an EDZ caused by stress concentration and damage in response to excavation are estimated by FEM analyses using the MBC model or the crack tensor model, and the fracture propagation code, FRACOD.

This paper describes the results of hydraulic fracturing test which is one of the most important factor for input data of underground facility design, and the relation between the result of hydraulic fracturing test and geological structures.

2. Location and geology

Hydraulic fracturing tests were performed in the AN-1, MIU-2 and 3 boreholes at the Shobasama Site, and MIZ-1 borehole at the construction site of Mizunami Underground Research Laboratory, Mizunami city, Gifu prefecture. 10 to 20 tests per one borehole were performed at the Toki granite.

The Toki granite has been lying in this region, and sedimentary formations have been covering the granite. The thickness of the sedimentary formations is about several ten to two hundreds meters. Toki granite are characterized upper highly fractured domain, lower sparsely fractured domain and faults. Tsukiyoshi fault is most large-scale fault around the site but is not active fault, and cuts MIU-2 and MIU-3 boreholes at the depth of about 900m and 700m, respectively.

3. Result and discussion of hydraulic fracturing tests

(1) Shobasama site

The result indicates that the stress magnitudes increase with depth. It is considered that the stresses are affected by small structures in the hanging wall of the Tsukiyoshi fault. Three zones are identified: 0 to 300 m, SH-Sh-Sv; 300 to 700 m, SH-Sh=Sv; 700 to 1,000 m, SH-Sv-Sh. In the hanging wall of the Tsukiyoshi fault, the in situ stress state may be different compared to stress in the footwall of the fault (800 to 1,000 m: Sv-SH-Sh). Thus the Toki granite at the Shobasama site can be divided into the three zones mentioned in the hanging wall of the Tsukiyoshi fault and a zone in the footwall of the fault, in terms of in situ stress state (stress decoupling).

The direction of the maximum principal stress in the horizontal plane changes at about 300 m from N-S (0 to 300 m) to NW-SE (300 to 1,000 m). The direction of maximum principal stress estimated by hydraulic fracturing test corresponds to the direction calculated by triangular surveying.

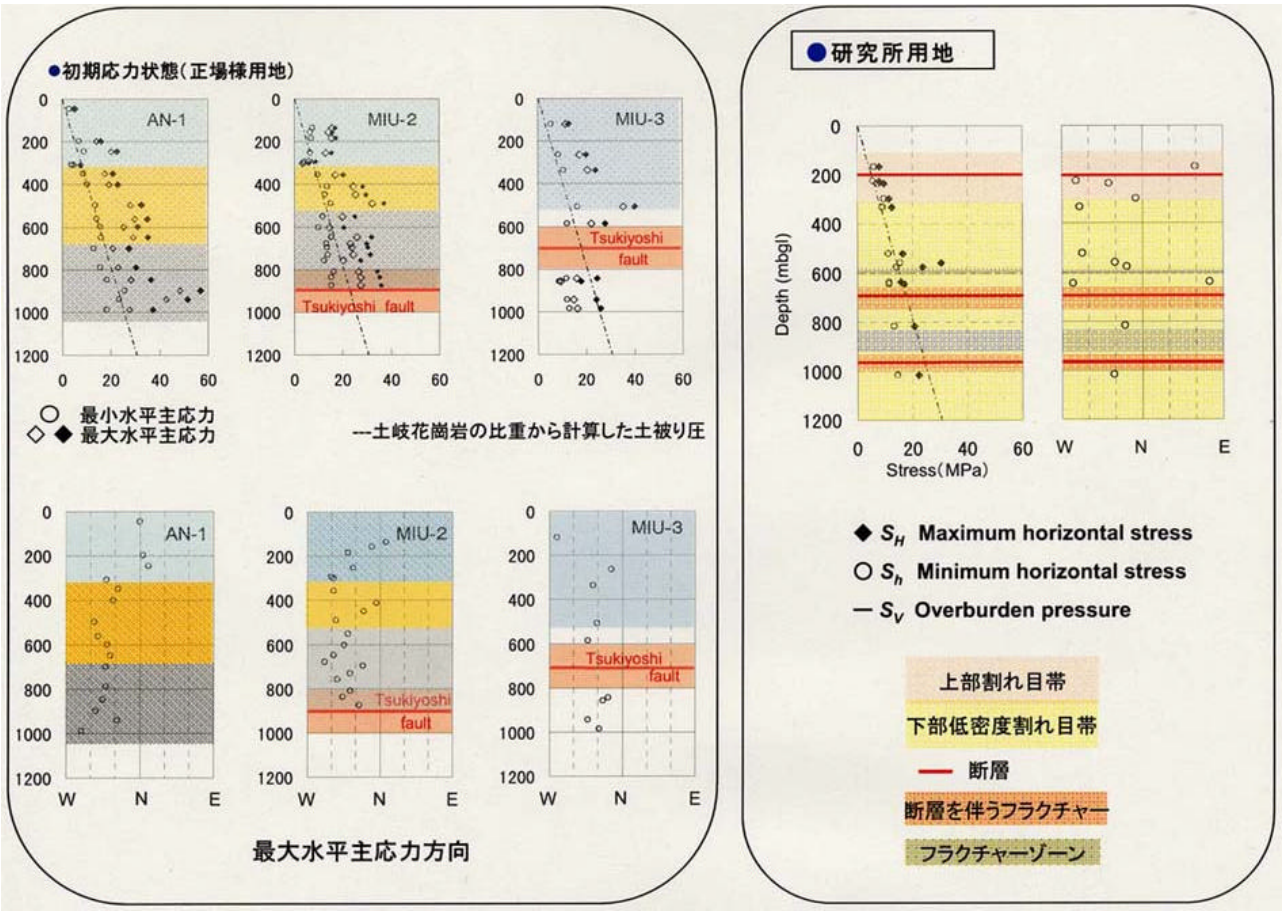
(2) MIU construction site

Stress decoupling observed at the Shobasama site is also observed at the MIU construction site. Two zones are identified: upper part (200 to 600 m), SH-Sh-Sv (reverse faulting state); lower part (600 to 1,000 m), Sv-SH-Sh (strike-slip faulting state).

The directions of the maximum principal stress in the horizontal plane are scattered in N-S to E-W direction, but almost NW-SE direction.

4. Conclusions

In situ stress state of the Toki granite at the Shobasama site and MIU construction site estimated by hydraulic fracturing tests are divided into some zones affected by density of fractures and faults, and stress decoupling are observed in both site. The relation between in situ stress state and geological structures will give useful information to classify of rock mass. In Phase II (Construction Phase), detailed stress measurements will be performed in the horizontal research galleries.


●初期応力状態（正場様用地）
AN-1
MIU-2
MIU-3
Tsukiyoshi fault
○ 最小水平主応力
◇◆ 最大水平主応力
---土岐花崗岩の比重から計算した土被り圧
W N E
最大水平主応力方向
●研究所用地
Depth (mbgl)
Stress(MPa)
◆ S_H Maximum horizontal stress
○ S_h Minimum horizontal stress
— S_V Overburden pressure
上部割れ目帯
下部低密度割れ目帯
断層
断層を伴うフラクチャー
フラクチャーゾーン