## 2 Overview of the geoscientific research in the MIU Project

The MIU Project is located at the Shobasama Site in Akeyo-cho, Mizunami City, Gifu Prefecture. The geoscientific research carried out for the MIU Project is primarily focused on the study of the granite at the site; granite being a widely distributed crystalline rock type in Japan. Fortuitously, JNC had carried out an extensive geoscientific research program in and around the nearby Tono Mine. This research could be readily expanded to the benefit of the overall program.

By adopting a repetitive site investigation approach consisting of survey, prediction, and verification of the underground geological environment, JNC intends to confirm the applicability and accuracy of the investigation methods and the validity of the assessment of the geological environment. The project is divided into the following three Phases extending over a 20 years schedule (Figure 2.1).

**Phase I (Surface-based Investigation Phase)**
The multidisciplinary approach to geoscientific characterization from the surface has been implemented. Ultimately, all aspects of the geological environment deep underground as well as the effects on that environment of shaft excavation in Phase II will be predicted based on the surface-based investigations. Input to design of the facilities and scoping of the underground experimental activities has begun in Phase I.

**Phase II (Construction Phase)**
Site characterization and monitoring of the geological environment will continue during construction. During this Phase direct observations of the geological environment in the subsurface together with monitoring data will be used to test and assess the accuracy of the predictions made in Phase I about the geological environment and the effects of shaft excavation on that environment. During this Phase all new information will be combined with the existing knowledge on the geological environment to develop predictive models of the conditions expected to occur in the research galleries and the response to the excavations in Phase III. More detailed planning of Phase III activities will begin during this Phase.

**Phase III (Operation Phase)**
Detailed investigations, likely at several scales, with the intent to develop a detailed database and knowledge of the geological environment in the galleries are to be performed. The opportunity to develop geological information at scales of interest and in a variety of geological settings or conditions pertinent to the development of disposal technology are possible because of depth related variations in structural style and the hydrogeological and mechanical conditions. The facility layout will allow the study of processes that occur naturally in the subsurface, such as movement of solute in groundwater and other processes induced by excavation such as rock failure due to stress adjustment. Importantly, the accuracy of the predictions of the geological environment made in Phases I and II can be assessed, leading to improved models and expertise. In addition, the usefulness of the engineering techniques employed in the excavation deep underground can be assessed.

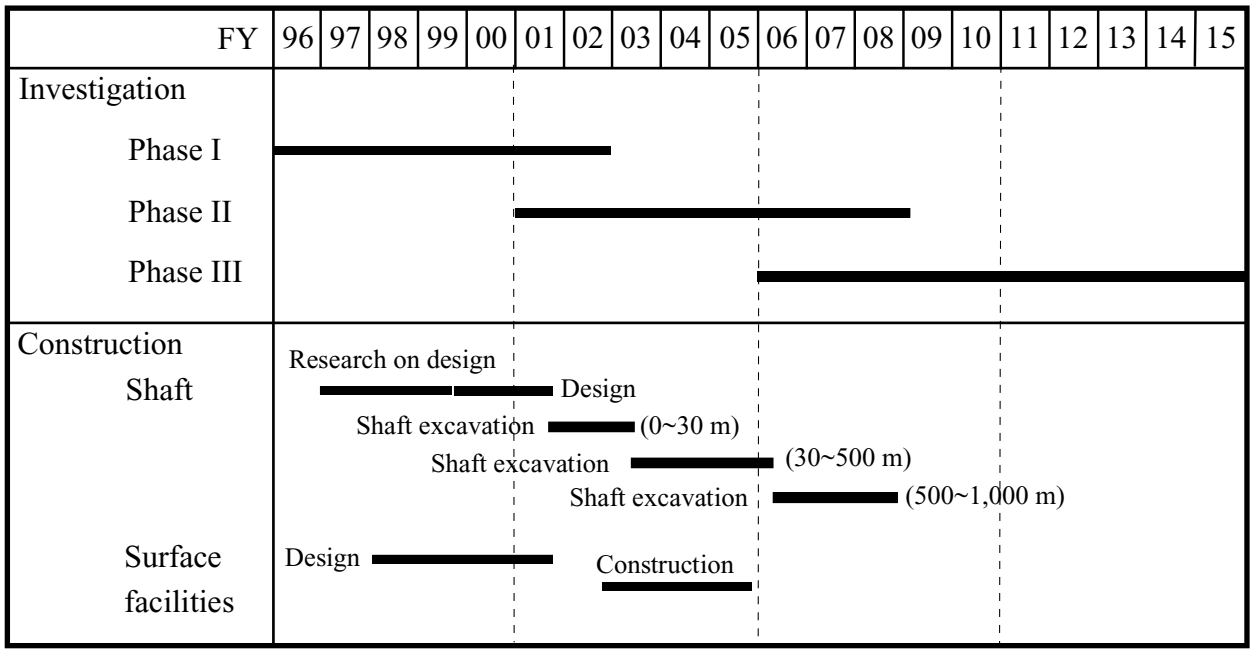



**Figure 2.1 Schedule** [8)]

## 2.1 Goals

The MIU Project is a study of a geological environment that has an appropriate extent and depth and has not been disturbed by human activities. The Project is expected to contribute to research and development for geological disposal as well as contributing to academic research on the deep geological environment in Japan. For this reason, it is essential that research should be comprehensive, systematic and relevant. Furthermore, the research is intended to not only develop an understanding of the geological environment and the effects of shaft and drift excavation on that environment but also at developing the methodology, applicable equipment and expertise for characterization of the subsurface.

In consideration of the above, goals of the entire MIU Project have been established. In addition, because the research activities differ from Phase to Phase, specific goals have been set for each Phase in order to give focus and direction to the research.

### 2.1.1 The goals of the MIU Project [(2)]

① To establish comprehensive techniques for investigating the geological environment

The first goal is to systematically combine the fundamental methodologies applied, developed and improved in JNC's geoscientific research and to provide comprehensive and integrated investigation strategies. These strategies are intended to demonstrate the effectiveness of a series of techniques for reliably investigating, predicting and modeling the characteristics of the deep geological environment and for evaluating the models of the geological environment. The reliability of the investigation techniques used and resultant data quality will be studied. It is expected that the techniques developed during the project will provide the technical basis for a variety of investigations.

② To acquire data on the deep geological environment

The second goal is to acquire high-quality data on the deep geological environment. These data, which will be backed up with results of geoscientific studies both in Japan and abroad, will be used to improve the reliability of conceptual models of the deep geological environment in Japan. They will also be used to evaluate engineering methods and equipment for the later Phases of underground construction and operations. The integrated dataset produced, which will include relevant results of geoscientific studies performed abroad, will provide a basis for other components of the R&D program for geological disposal in Japan.

③ To develop a range of engineering techniques for deep underground application

The third goal is to evaluate techniques for design and construction of large-scale underground facilities and to clarify the potential long-term effects of these techniques on the geological environment (e.g., possible interactions between construction materials and groundwater and/or bedrock.). Studies will also be carried out on the infrastructure for managing safety in such underground facilities.

### 2.1.2 The goals of Phase I [2]

① To acquire data on the undisturbed geological environment with surface-based investigation methods and to predict the characteristics of the geological environment and the effects of construction of underground facilities

These data will be used to construct geological, hydrogeological, hydrochemical and rock mechanical models for predicting the geological properties that will be encountered and the effects of construction in the next Phases.

② To establish methodologies for evaluating predictions

Criteria and detailed methodologies will be specified for checking the plausibility of predictions made in this Phase for comparison with the data obtained in the subsequent Construction Phase.

③ To formulate detailed design concepts for the underground facilities and to establish detailed research plans for the Construction Phase

Based on the data obtained in this Phase, as well as on modeling results, a detailed design concept for the underground facilities will be formulated and detailed investigation plans will be established for the construction Phase.

The goals ① and ② of the Phase I are set to achieve the goals ① and ② of the entire MIU Project. In the same way, the goal ③ of the Phase I is set to achieve the goal ③ of the entire MIU Project.

## 2.2 Applicability of the results

The results of the MIU Project will be categorized and reorganized from the viewpoint of geological disposal and provided to the Japanese national repository project and input to the development of safety regulations [8]. Coordination of the related organizations has advanced lately,* since the Long- term Program was revised and the implementing organization of the repository project, NUMO, was established in 2000. Therefore, based on this situation, re-examination on the organization and presentation of results would be done to advance the technology transfer.

## 2.3 Topography and geology

The MIU Project is being implemented at the Shobasama Site, a 14-hectare site owned by JNC. The Tono area, where the Shobasama Site is located, is bounded in the northwest by the Mino-Hida Mountains and in the southeast by the Mikawa Mountains. Topographically, the Tono area forms a roughly boat-shaped,

* Since the Japanese version of this report was written.

elongate topography with the axes of the linear ridges and valleys extending northeast-southwest between the two Mountains, as is shown in Figure 2.2. The Kiso River forms a deep valley cutting through the northern mountains. The boundary between the southeastern mountains and the boat-shaped hills is clearly marked by the northeast-southwest oriented Byobusan Fault, named after nearby Mt.Byobusan (794.1 m). This fault can be identified in the northeast by the presence of a steep cliff with talus deposits, although the steep cliff is less distinct toward the southwest. In the central part of this region, the Toki River flows from northeast to southwest. Terraces developed along the Toki River and its tributaries are composed of flat-lying, alluvial deposits.

The geology of the Tono area consists of sedimentary rocks of the Mino Belt (Jurassic to Cretaceous), granites and rhyolite (Cretaceous), and later sedimentary rocks (Miocene and Pliocene).

The sedimentary rocks of the Mino Belt are mostly sandstone, mudstone and chert with a strike of NE-WSW and represent repeated sequence of Triassic to Late Jurassic strata [(9)].

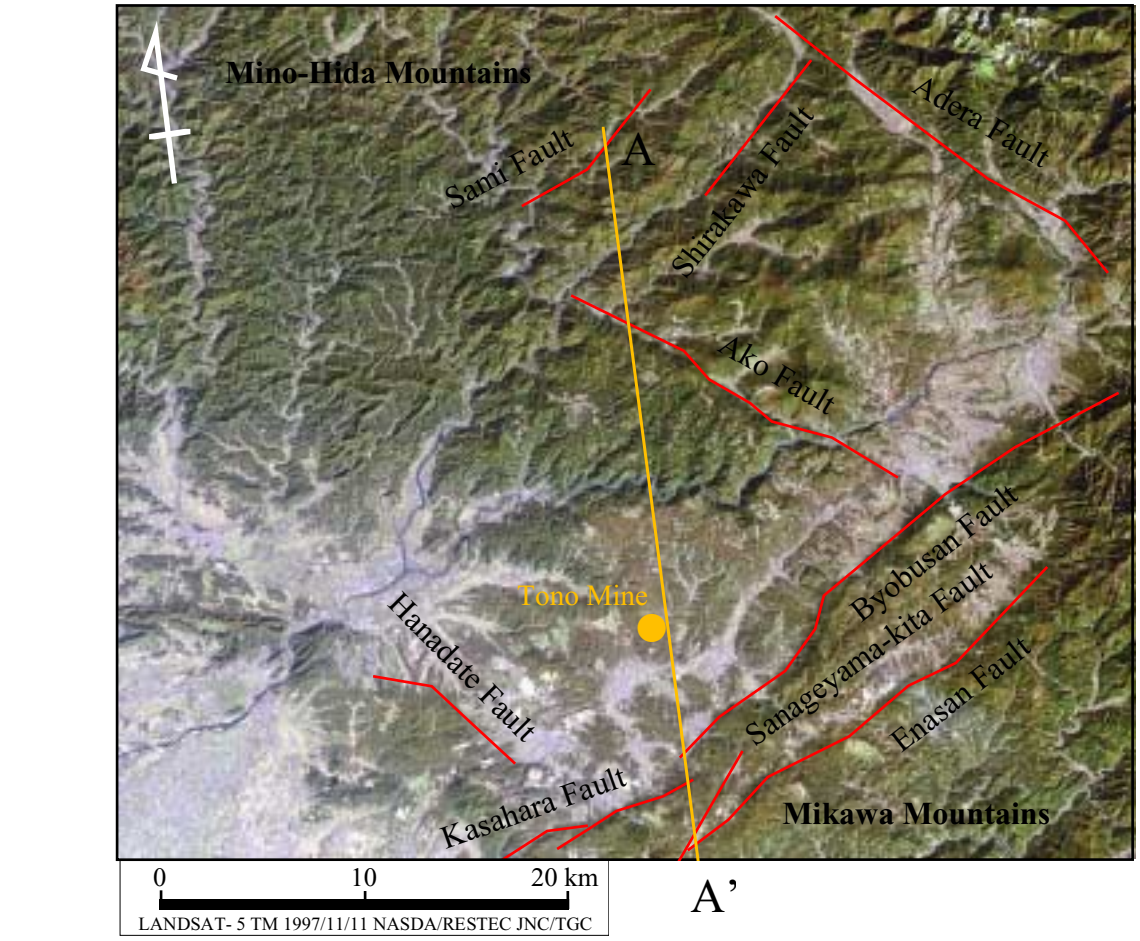
Nohi Rhyolite occurs in Kamado district, Mizunami City in the northeastern part of the Tono area and to the east of it. It is composed of monolithologic, welded tuff, and is intruded by Toki Granite in Mizunami City [(10)].

Granites are mainly the Ryoke Granite type and distributed in the Mino-Mikawa Plateau. The Toki Granite, 10 km in diameter, is exposed in the Toki-Mizunami Basin and intrudes into sedimentary rocks of the Mino Belt discordantly. The Toki Granite is regarded as a part of the Naegi-Agematsu Granite Complex located to the east. NNW quartz porphyry dikes [(11)] are intrusive into the Toki Granite near Toki City and in Mizunami City.

Miocene sedimentary strata (Mizunami and Kani Groups) unconformably overlie the basement rocks in the Toki-Mizunami and Kani basins. The Mizunami Group is divided into Toki Lignite-bearing Formation, Hongo Formation, Akeyo Formation and Oidawara Formation. As a whole, there is a trend of upward fining and wider distribution indicating transgression. The thickness of the Mizunami Group in the south of Toki-Mizunami Basin is over 300 m. The Pliocene Seto Group consists mainly of gravels (Toki Gravel) of chert and Nohi Rhyolite. A clay bed (Tokiguchi Formation) occurs in the lower horizon of Seto Group. [(12)]

There is a clear relationship between the geology and topography. The mountainous regions, hilly regions and hilltops correspond to Mesozoic basement rocks, Neogene/Quaternary sedimentary rocks and the Pliocene Seto Group (Toki Gravel), respectively [(13)].

The area is divided into several regional scale blocks formed by faulting and tilting movements. Geologically important faults include the Byobusan and Kasahara Faults occurring between Nakatsugawa-Tajimi (strike: NE-SW), Enasan Fault parallel to the above but to the south, and Sanageyama Fault along the east side of Mt.Sanageyama. All of these faults form steep cliffs. The Ako and Hanadate Faults crosscut the Byobusan Fault and the Kasahara Fault, nearly perpendicularly, to the north [(14)]. In Mizunami Basin are the Tsukiyoshi Fault (strike: EW) and the Yamada Fault Zone (strike: NE-SW to WSW) [(12)].



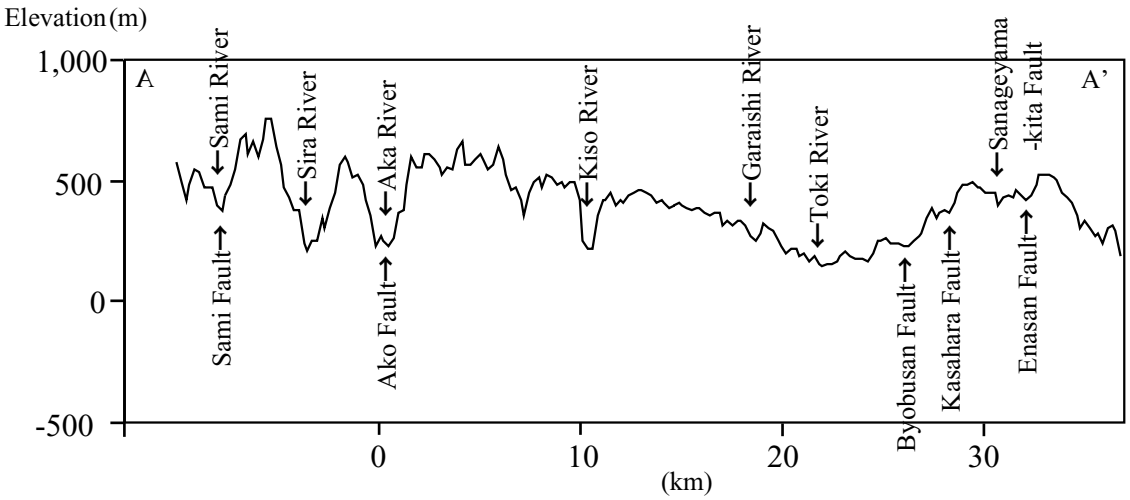




**Figure 2.2 Topography of the Tono area (LANDSAT photograph and cross section)**

The Shobasama Site is located in the hilly country between the Kiso and Toki Rivers, where the Mizunami and Seto Groups overlie the Toki Granite. Geology in the vicinity of the Shobasama Site is shown in Figure 2.3.

### 2.4 Planned facilities

Planned facilities for the MIU Project consist of the surface facilities, two shafts and the research galleries (Figure 2.4). According to the construction program of facilities decided by 1999 FY, the following shafts and research galleries are planned.

- A Main Shaft for access to about 1,000 m depth
- A Ventilation Shaft
- Two principal levels for research galleries at different depths (Main and Middle Stages)
- A spiral ramp to avoid premature disturbance of the Tsukiyoshi Fault by the Main Shaft intersection. The ramp will allow excavations to step out from the fault into the less disturbed part of the hanging wall and preparation for detailed investigations of the fault.

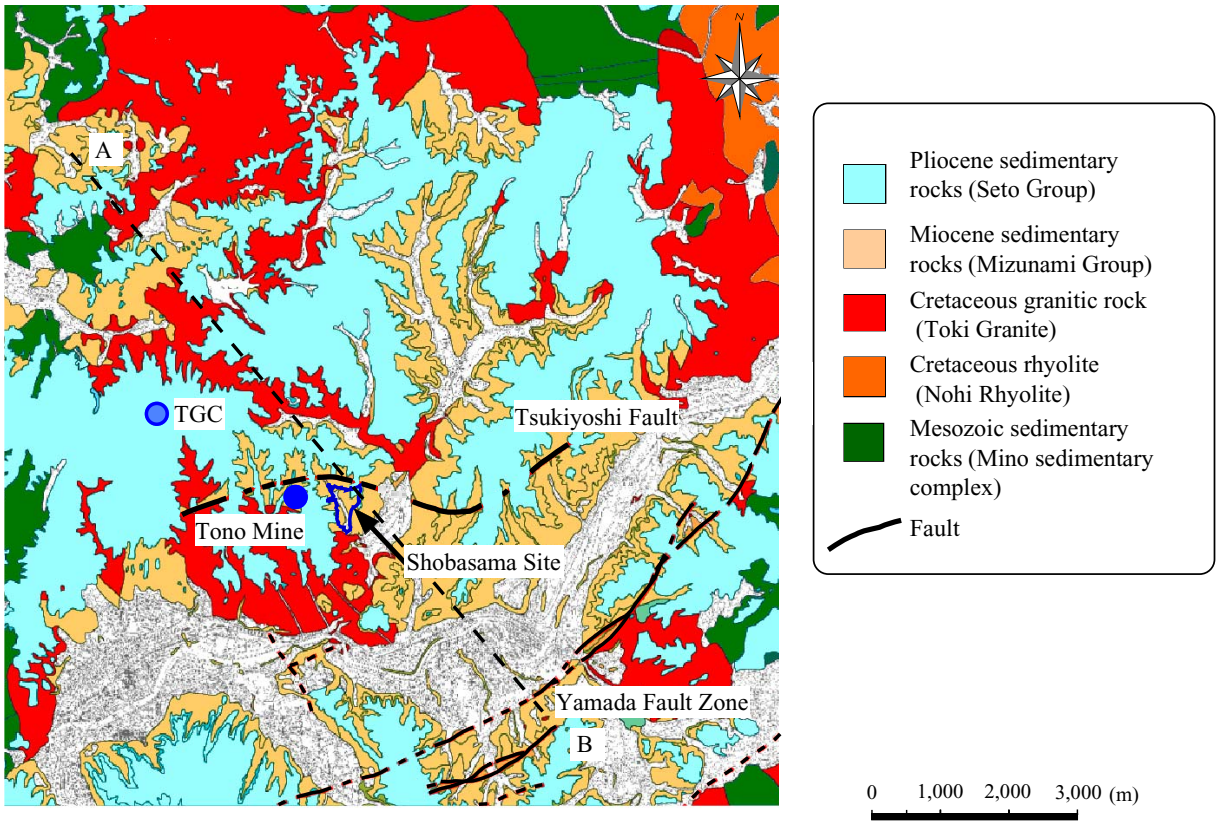
According to results from previous investigations, fracture frequencies are lowest between 400 m and 700 m depth. Fracture frequencies are higher above and below this range. The high fracture frequency below 800 m depth may be related to Tsukiyoshi Fault deformation. Thus, the research galleries at the Main and Middle Stages mentioned above are planned to be excavated at about 500 m and 1,000 m depths, which will allow detailed investigations in two different structural domains.

Planned facilities at surface consist of research and administration buildings, sample storage facility, an equipment maintenance facility, the shaft head frames, a muck deposit and a wastewater treatment facility.

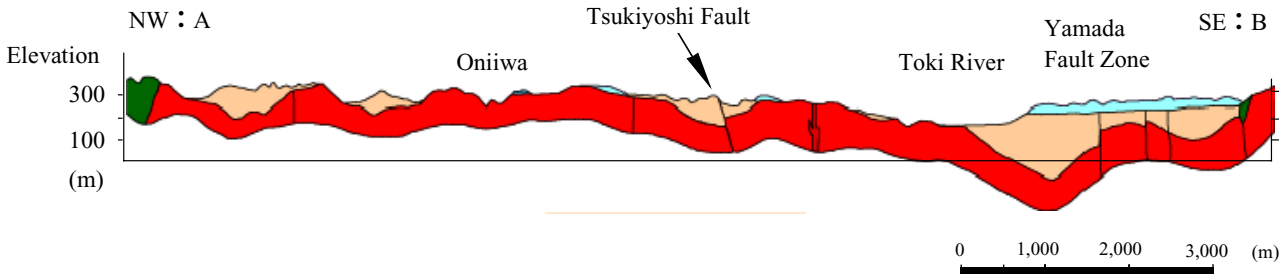
The design of facilities will be optimized as the data are accumulated in Phase I, and as Phase II provides more detail on the subsurface.

### 2.5 Project site

As described above, the MIU Project is located at the Shobasama Site, owned by JNC (Figure 2.5). In order to improve the accuracy of all predictions including groundwater flow simulations carried out in the MIU Project, the study area should be established with consideration of the topography and properties of the geological environment. Thus, the results of the Regional Hydrogeological Study Project (RHS Project), which completely encompasses the Shobasama Site, can be fully utilized [(15)].




**(a) Geological map**




**(b) Cross section of the line A-B in the geological map**

**Figure 2.3 Geology in the vicinity of the Shobasama Site**

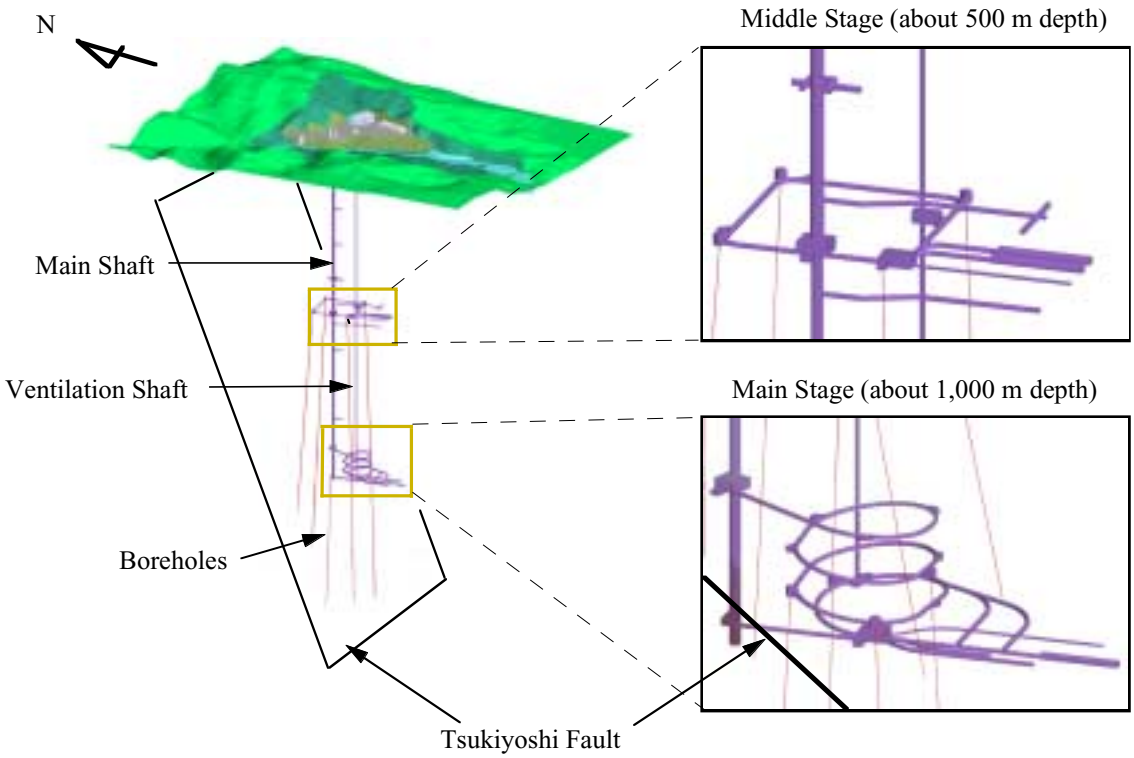



**Figure 2.4 MIU conceptual design**

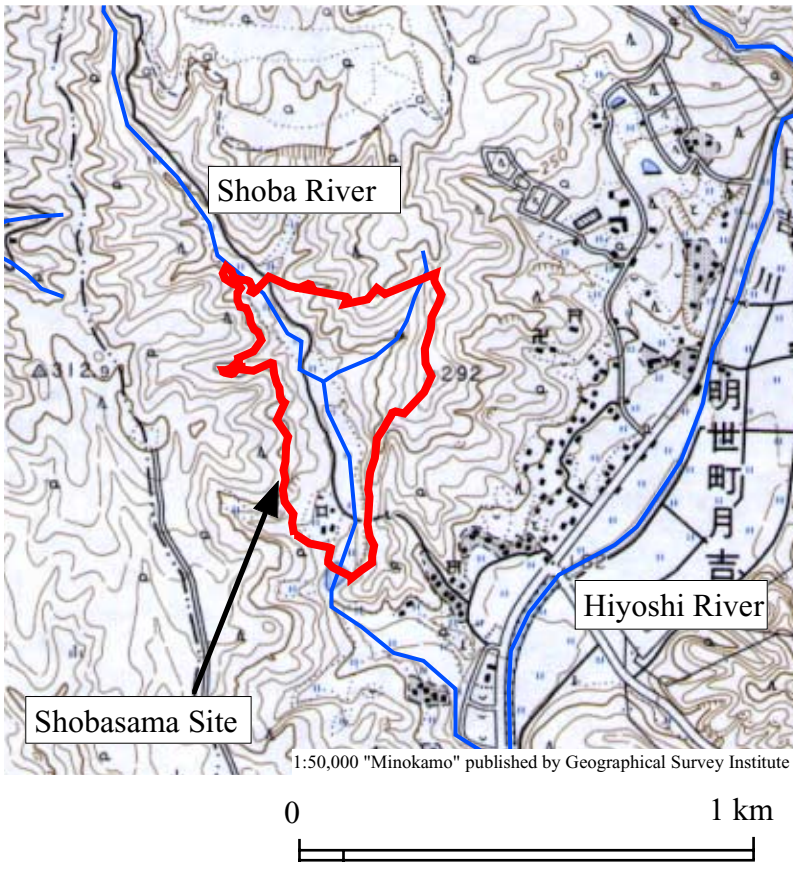



**Figure 2.5 Location map of the Shobasama Site**