TDEM

Survey parameter tests were conducted at the beginning of the survey to aid in determination of the optimum measurement configuration for this survey. These tests were performed at a station where the thickest section was expected, so that the penetration of the measurements could be assessed. The test site was also chosen to be at long offset from the current line so that the effect of electromagnetic noise upon the measurements could be considered.

During these tests, measurements were made at an offset of nearly 4.5 km from the center of the line source and air and permeable core receiver coils with effective areas of 50 and 9,000 m^2, respectively, were tested. While permeable core loops yield higher signal and have a greater depth of penetration, they can be difficult and time consuming to deploy and retrieve and they have inherently lower frequency response. Small loops are more easily handled and have much higher frequency response, but they have limited depth of penetration.

Measurements were made at a number of filter settings and at two frequencies (3kHz and 4kHz). From these tests proper parameters for data collection were determined.

(e) Measurement Stations

Station Positioning

Survey stations were positioned by land survey with use of topographic maps at a scale of 1:10,000 marked with Universal Transmercator (UTM) coordinates. Station elevations were also determined by land survey.

Station Locations

The total length of the 12 survey lines is about 13.5 km, and measurements were made at a total of 566 survey stations as summarized in the following table and Figure 11.2.3-4.

Site No. / TDEM line		Coordinates (A) - Start point of line -			Coordinates(B) - End point of line -			Line length	No. points
		Easting	Northing	(EL.m)	Easting	Northing	(EL.m)	(km)	(Nos)
TEM	TMB 3.0	610,735	2,191,989	573	613,190	2,190,567	537	2.9	146
	TMB 3.9	638,039	2,175,421	481	639,425	2,175,622	497	1.4	71
	TMB 8.1	642,300	2,175,900	491	642,681	2,175,777	500	0.4	21(6)
	TMB 11.0 a	644,967	2,174,972	468	645,573	2,174,176	501	1.0	51
	TMB 11.0 b	645,752	2,174,252	523	645,274	2,174,103	482	0.5	26
	TMB 11.0 c	645,126	2,174,515	490	645,332	2,174,244	541	0.34	18(18)
	TMB 11.0 d	645,419	2,174,625	564	645,601	2,174,387	509	0.3	16
	TMB 11.0 e	645,569	2,174,676	621	645,751	2,174,438	541	0.3	16
	TMB 46.0	665,270	2,147,150	465	665,877	2,146,355	425	1.0	51
	KOK-ING B	point sounding							15
							sub-total	8.14	455
TDEM	TDEMB 29.4	653,231	2,160,066	935	654,126	2,159,719	1292	1.0	21
	TDEMB 30.0	654,005	2,158,937	950	654,741	2,157,190	640	2.4	49
	TDEMB 35.0	657,600	2,155,400	581	659,061	2,154,035	801	2.0	41
							sub-total	5.4	111
							total	13.54	566

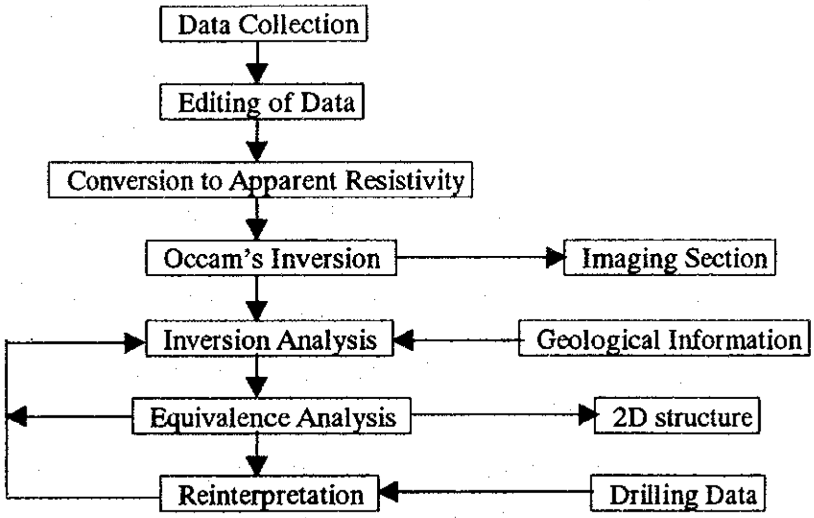
Noise

Electromagnetic noise is induced in the receiver coil by power lines and from movement of the receiver coil in the earth's magnetic field by wind. Repetitive voltage measurements were made and averaged or 'stacked' to minimize these effects. The electromagnetic noise level was very low in the majority of the survey area but noise from powerlines was appreciable in the vicinity of the drill rig at TMBJ33.

(f) Data Processing

The data analysis procedure used in this study is presented schematically in the flow chart of Figure 11.2.3-5. The data which has been recorded in the field is first transferred from the PROTEM receiver to a personal computer, using the Geonics program "PROTEMC". This data is stored in ASCII data files which are then read by a data inversion program.

Figure 11.2.3-5 Flow Chart of Data Analysis



In the first phase of data processing, the decay voltages for each gate are transformed into late-time apparent resistivity values, by normalization with respect to field data measurement parameters such as loop dimensions, receiver gain, current and sounding geometry.

The voltages, V_o (in units of mV), which are measured by the PROTEM receiver are converted to magnetic field decay rate, *dB/dt* (nV/m^2), by the following formula (Geonics, 1992).

$$\frac{dB}{dt} = \frac{V_0 \cdot 19200}{E \cdot 2^n}$$

where *E* is the receiver coil moment (m^2), and *n* is the amplifier gain setting. Apparent resistivity ρ_a (ohm-m) are then given as a function of time *(t)* by,

$$\rho_a(t) \cong \frac{\mu}{4pt_c}\left(\frac{2\mu M}{5t_c \, dB/dt}\right)^{2/3}$$

in which, μ is magnetic permeability ($*4\pi*10^{-7}$ H/m), t_C is measurement time or the gate center time in seconds, and *M* is transmitter moment which is the product of loop area (m^2) and current (A).

An automatic one-dimensional inversion technique was used to generate resistivity models composed up to 19 layers for TEM data and 30 layers for TDEM data. In this process, the resistivity of the layers of a candidate model, which is chosen by the inversion program, are iteratively changed and response curves are computed to determine the model whose response best fits the observed data. The model is not restricted by the condition that the resistivity of the layers change smoothly with depth, as they are with the Occam or `smooth` inversion method. Models derived by this technique, without artificial parameterization, can be used to produce images which aid in visualization of underground structures. The imaging results were also used to estimate initial model parameters for the interactive one-dimensional inversions which followed.

Interactive inverse processing is used to obtain one-dimensional resistivity structures in areas where the geological section can be assumed to be composed of a more limited number of discretely layered geoelectric units. In this process we can estimate resistivity and thickness parameters for models composed of up to 8 layers. The inversions are done by the Inman style automatic ridge regression approach to nonlinear least squares curve fitting. This procedure is called as a "layered earth inversion".

Finally, equivalence analysis was performed to estimate uncertainties in the inversion results. This is done by finding alternate models whose response fits the data nearly as well as the best-fit model. In this procedure the resistivity and thickness parameters of the best-fit model are incrementally varied (increased and decreased) until a user-specified fit-error limit is reached. This is done to determine the extent to which the model can be modified while keeping the error of fit within acceptable guidelines. Equivalence analysis indicates the allowable range of each of the model parameter.

The inversion program which was used in this study is "TEMIX-XL" developed by Interpex Ltd. and "TDEM data analysis program" by MINDECO.

Processing of the TDEM data is essentially the same as that for the PROTEM data. The software used in the TDEM processing is proprietary software.

(g) Sounding Results

TEM survey

Resistivity sections by TEM survey, which are shown in Figure 11.2.3-6 to 11.2.3-15, were produced by Occam and layered earth inversions for each data sets. The survey line coordinate is given on the horizontal axes of each figure and the elevation above sea level is shown on the vertical axes of the plot. The units of these axes are meters and the vertical exaggeration of the plot is one to one. The color scale to the right of the plot indicates resistivity in Ohm-m. In the above figures, planned tunnel level is also presented in these figures by solid lines or circles. The feature and characteristic of each resistivity section confirmed by TEM survey are as follows.

< TEM Survey Line TMB 3.0 >

The TEM survey line TMB3.0 extends from NW to SE direction along the Kok-Ing No.2 (B-J) tunnel line and is 2.9 km in survey length. Clear horizontal discontinuities of resistivity, which probably indicate the fracture zone by fault or geological boundary, exist at the No.530, No.1,510, and No.2,200 of the survey point. Therefore, it can be classified in total four structure blocks at this section on the basis of the above horizontal discontinuities of resistivity. (refer to Figure 11.2.3-6)

The first structural block is located between No.0 and No.530, and resistivity of the block shows ranging from 200 to 2,000 ohm-m, which mean relatively high resistivity, and it is identified as granite on the basis of existing geological data. Furthermore, the layered section of the block is mainly composed of two to four layers.

The second block is located between No.530 and No.1,510 with the resistivity ranging from 5 to 400 ohm-m. The block is characterized by low resistivity as a whole in comparison with that of another blocks. In this case, it is considered that the feature of low resistivity is probably ascribed to the existing of fractured zone by the fault on a large scale. Furthermore, the layered section of the block is mainly composed of three layers. The resistivity of the first layer ranges from 40 to 200 ohm-m, and the thickness varies ranging from 30 to 90 m. The resistivity of the second layer ranges from 5 to 100 ohm-m, and the thickness varies ranging 5 to 30 m. Furthermore, that of the third layer shows more than 120 ohm-m. In this block, the horizontal discontinuity of resistivity, which probably indicates fracture zone, also exists at the No.750, and around this area high resistivity zone is recognized at the deeper place.

The third block exists between No.1,510 and No.2,200 and shows 60 to 1,000 ohm-m as resistivity. The block is identified as P3 formation of Permian age, which are composed of sandstone, shale and tuff, on the basis of existing geological map. The layered section is mainly composed of two to three layers. The resistivity of the first layer ranges from 150 to 1,000 ohm-m, and the thickness varies ranging 30 from 100 m. That of the second layer ranges from 60 to 130 ohm-m, and the thickness varies up to 50 m or more. Furthermore, that of the third layer shows ranging from 600 to 1,000 ohm-m.

The fourth block is located between No.2,200 to No.2,900, and the resistivity of the block varies ranging from 200 to 400 ohm-m. Furthermore, the feature of resistivity distribution provides comparatively stable.

< TEM Survey Line TMB 3.9 >

The TEM survey line TMB3.9 extends from E to W direction on a parallel with nearby Ing-Yot No.2 tunnel and is 1.4 km in survey length. Resistivity along the section ranges from 40 to 900 ohm-m (refer to Figure 11.2.3-7). Resistivity around the tunnel inlet side (No.0-No.1,050) of the line is higher than those of the exit side (No.1,05-No.1,400). In this case, the resistivity of former shows the range of 200 to 900 ohm-m, and the latter show the range of 50 to 200 ohm-m, respectively.

The layered section is mostly composed of three or four layers. Variations in resistivity values of the section are probably caused by different rock facies, metamorphic grade, the existence of underground water and so on. Also, the horizontal discontinuities of resistivity, which probably indicate fracture zones by faults, exist at the No.490, No.830, No.1,050, and No.1,250.

According to the geological condition by existing data, the area of tunnel inlet side is dominated by TRhf (Huai Fak formation) represented by sandstone and tuff interbedded with slate, on the other hand, the tunnel outlet side shows a dominance of CPhk (Huai Krai formation) composed by meta-sandstone interbedded with slate. It is inferred that geological boundary line of the above two formations exists at the No.830 or No.1,050. In addition, existing drilling data of DHB4, which is located nearby No.840, shows CL class as rock grade with sandstone, shale and limestone up to 120 m in depth. From these facts, on the occasion of tunnel excavation near the above discontinuity zones, much attention should be paid to the existing of fractured zone caused by the fault and removal of abnormal groundwater and so on.

< *TEM Survey Line TMB 8.1* >

This TEM survey line TMB8.1 also extends E to W direction on a parallel with nearby Ing-Yot No.2 tunnel and is 0.4 km in line length. Resistivity values along the section are relatively low ranging from 16 to 80 ohm-m, which is identified as sedimentary rocks (slate, quartzite etc.). (refer to Figure 11.2.3-8)

One resistivity discontinuity is clearly found at the No.150 with inclined feature toward tunnel inlet direction. And, the resistivity at the area of tunnel inlet direction shows ranging 20 to 30, which mean low resistivity. According to the existing geological data, the area around survey line is occupied by CPnb (Nam Bong formation) accompanying with slate and quartzite interbedded with sandstone. Furthermore, drilling data of DHB8SP performed nearby No.80 show the existence of fractured slate (D as rock class), which is probably ascribed to fault on a large scale, up to about 80 m in depth, and this fact is in harmony with an existing of the above low resistivity zone. In addition, on the occasion of tunnel excavation, particular attention should be paid to the presence of this low resistivity zone.

< *TEM Survey Line TMB 11.0 a* >

The TEM survey line TMB11.0 a, which is 1.0 km in line length, is situated around the Phu Sang area and is located on southward of Ing-Yot No.2 tunnel alignment. Confirmed resistivity of this line is characterized by low values except for both the surface part and depths part at the center portion. (refer to Figure 11.2.3-9)

Layered earth inversion of the section clarified the existence of two and three layers. The resistivity of the first layer ranges from 30 to 300 ohm-m, and the thickness varies ranging from 30 to 120 m. That of the second layer shows 10-15 ohm-m at No.0-No.130, 4-9 ohm-m at No.130-No.530 and 1-4 ohm-m at No.530-No.1,000. These values are characterized by remarkable low resistivity, and it is inferred that zone at No.130-No.1,000 have been affected by heated ground water, and cracks of basement rock at this area may be partly filled by that. The third layer, which has raised structure at the center of this line, shows relatively high resistivity (130 to 250 ohm-m). There is a possibility that the layer is composed of igneous rocks, which mean probably granite or granite porphyry, and the above heated groundwater may be caused in contact with these igneous rocks, which is continued to at great depths, at the deeper portion.

The existences of horizontal resistivity discontinuity are obtained at No.130, No.430 and No.540. The former corresponds to boundary line of low resistivity zone (10 ohm-m or less), and the last two are located around relatively high resistivity zone.

Furthermore, according to the existing geological data, this area is underlain by CPhk (Huai Krai formation) composed by meta-sandstone interbedded with slate, excluding around starting point of survey line. In this case, geological condition around starting point consists of CPnb (Nam Bong formation), which is composed of slate and quartzite interbedded with sandstone. The drilling data of DHB5 where is located around starting point of line revealed the existence of sandstone and slate, and rock quality shows mostly CM or CH as rock class nevertheless existing of CL class is found between 50 to 85 m in depth. Also, resistivity of this area is confirmed ranging from 10 to 15 ohm-m. Furthermore, by following table, these resistivity values may support the idea that geological condition of this area is derived from marine sediments.

Taking the above factors into consideration, it is inferred that tunnel alignment, where passes around DHB5 location, is situated on outer area of zone strongly affected by heated ground water because that is located on outside of remarkably low resistivity area. However, as for adit No.2 alignment, adit construction must be taken potential hazards into account because location of that is presumed to be situated on the above remarkably low resistivity area. Furthermore, clear solution for these matter should be further studied in detail based on the additional investigation from the viewpoint of hydrogeological sense, for example drilling investigation, physical survey, including detailed groundwater quality tests.

Range of Typical Resistivity as for Geological and Rocks

Geologic Age	Marine sediments sandstone, shale, graywacke	Non-marine sediments sandstone, claystone	Volcanic rocks basalt, rhyolite	Plutonic rocks granite, porphyry	Chemical sediments limestone, dolomite etc.
Cenozoic (Quaternary, Tertiary)	1 – 10	15 - 50	10 – 200	500 - 2,000	50 - 5,000
Mesozoic	5 – 20	25 - 100	20 – 500	500 - 2,000	100 - 10,000
Paleozoic (Carboniferous)	10 – 40	50 - 300	50 - 1,000	1,000 - 5,000	200 - 100,000
Paleozoic (before Carboniferous)	40 – 200	100 – 500	100 - 2,000	1,000 - 5,000	10,000 - 100,000
Pre-Cambrian	100 - 2,000	300 - 5,000	200 - 5,000	5,000 - 20,000	10,000 - 100,000

* Unit : ohm-m
* The above table is taken from "Handbook of Physical Contents, 1966"

< TEM Survey Line TMB 11.0 b >

The survey line, which is 0.5 km in line length, is also located on southward of Ing-Yot No.2 tunnel line and intersects at almost right angle toward TMB11.0 a line. The resistivities of this line are also characterized by low values at the deeper part. (refer to Figure 11.2.3-10)

The layered section of this block is made up of two layers excluding between No.0 and No.90, where shows three layers structure. The resistivity of the first layer shows ranging from 20 to 120 ohm-m, and the thickness of that varies between 20 and 180 m. That of the second layer shows remarkable low resistivity values (7 ohm-m or less), which are a harmony with the results of TEM11.0.a survey line, and this layer presumed to be continued to low resistivity layer of that. Horizontal resistivity discontinuities are found out at No.90 and No.370, however, these are merely recognized at shallow portion up to about 50 m in depth. In addition, according to the existing geological data, geological condition of this area is also corresponds to CPhk (Huai Krai formation) composed by meta-sandstone interbedded with slate.

< TEM Survey Line TMB 11.0 c >

The line is located on parallel with TMB11.0 a survey line and is also situated at southward of Ing-Yot No.2 tunnel line. This line is 0.34 km in survey length. Clarified resistivity of line is also characterized by low values at the deeper part. (refer to Figure 11.2.3-11)

Layered earth inversion revealed the existence of two layers excluding the zone between No.240 and No.340, where is located on the northwestward of survey line. The resistivity of the first layer ranges from 50 to 90 ohm-m, and the thickness varies ranging from 120 to 150 m. That of the second layer shows less than 2 ohm-m. The existence of this low resistivity layer also is a harmony with the results of TEM11.0 a survey line and is presumed to be continued to low resistivity layer of that. That of the third layer shows 130 ohm-m and a general tendency of distribution as for that suggests that low resistivity layer thin toward northwestward. Furthermore, at this line, no horizontal resistivity discontinuities are found out. In addition, according to the existing geological data, geological condition of this area is also corresponds to CPhk (Huai Krai formation) composed by meta-sandstone interbedded with slate.

< *TEM Survey Line TMB 11.0 d* >

This line, which is 0.3 km in survey length, is also located on parallel with TMB11a survey line and is situated at southward of Ing-Yot No.2 tunnel. Clarified resistivity of survey line is also characterized by low values at the deeper part. (refer to Figure 11.2.3-12)

Layered earth inversion revealed the existence of total three layers. The resistivity of the first layer ranges from 20 to 120 ohm-m, and the thickness varies between 80 and 100 m. That of the second layer shows ranging from 4 to 7 ohm-m at the No.0-No.90 and 2 ohm-m at the No.90-300, respectively. The existences of these low resistivity layer are also a harmony with the results of TEM11.0 a survey line and are presumed to be continued to low resistivity layer of that. Furthermore, that of the third layer shows ranging from 220 to 230 ohm-m. Furthermore, clear horizontal resistivity discontinuity is found out at No.90. In addition, according to the existing geological data, geological condition of this area is also corresponds to CPhk (Huai Krai formation) composed by meta-sandstone interbedded with slate.

< *TEM Survey Line TMB 11.0 e* >

The line, which is 0.3 km in survey length, is also located on parallel with TMB11a survey line and is situated at southward of Ing-Yot No.2 tunnel. Clarified resistivities of line are also characterized by low values at the deeper part. (refer to Figure 11.2.3-13)

Layered earth inversion clarified the existence of total three layers. The resistivity of the first layer ranges from 30 to 220 ohm-m, and the thickness varies ranging from 60 and 90 m. That of the second layer shows ranging from 5 to 6 ohm-m between the No.0 and No.90 and ranging from 1 to 3 ohm-m between No.90 and 300, respectively. The existences of these low resistivity layer are also a harmony with the results of TEM11.0 a and TEM11.0 d survey line, and it is presumed to be continued to low resistivity layer of that. And, a general tendency of resistivity distribution as for both TEM11.0 a and TEM11.0 d survey line suggests that low resistivity layer thin toward northeastward. Furthermore, that of the third layer shows ranging from 200 to 260 ohm-m, and tunnel alignment passes in this third layer. Clear horizontal resistivity discontinuity is found out at No.90. In addition, according to the existing geological data, geological condition of this area is also corresponds to CPhk (Huai Krai formation) composed by meta-sandstone interbedded with slate.

< TEM Survey Line TMB 46.0 >

The TEM survey line TMB46.0, which is 1.0 km in line length, extends from NW to SE direction around No.7 adit of Ing-Yot No.2 tunnel. This line is characterized by the existence of remarkable high resistivity zone as a whole in comparison with that of another TEM survey line excluding surface part. (refer to Figure 11.2.3-14)

The layered section reveals the existence of two layers. The resistivity of the first layer shows ranging from 20 to 170 ohm-m, and the thickness of this layer ranges from 10 to 50 m. It is inferred that this layer corresponds to both thick alluvial deposits and weathered rock zone. That of the second layer shows ranging from 800 to 10,000 or more, which means remarkable high resistivity. According to the existing geological data, this area is occupied by TRhf (Huai Fak formation) composed by sandstone, tuff interbedded with slate and TRpl (Pa Lae formation) represented by limestone. In general, limestone is known to show high resistivity as compared with another geology, and TRhf formation is also proved to show high resistivity as a result of electric logging performed by JICA. These facts are an excellent harmony with the existence high resistivity zone on this survey line.

Three horizontal resistivity discontinuities are found out at No.90, No.550 and No.690. It is inferred that these discontinuities correspond to the presence of fractured rock caused by fault. Taking geological map and performed two drilling data (DH7AD1and DHB46SP), where is located on/around survey line respectively into consideration, there is a large possibility that the discontinuity at the No.90 corresponds the geological boundary line between TRhf formation and TRpl formation. In addition, The boring data of the former shows sandstone facies (CM to CH as rock class) and the latter shows limestone facies (CM to CH as rock class), respectively.

< TEM Survey Kok-Ing B >

TEM survey Kok-Ing B is located on Kok-Ing No.2 tunnel and is performed by point sounding method for the purpose of confirmation of boundary point between Bs formation (Tertiary basalt) and Permian P3 formation, which is composed of sandstone, shale, tuff and limestone, at the total three point. In addition, P3 formation is overlain by Bs formation, and latter is well exposed on the mountain ridge of this area. Coordinates at the center of each survey point (survey grid) are as follows. In this time, each point interval has about 1 km.

B1 610,475E, 2,189,727N
B2 611,615E, 2,189,365N
B3 612,485E, 2,188,959N

Resistivity models of each survey point are shown in Figure 11.2.3-15. Resistivity models of B-1 and B-2 points show a similar two layers structure, and resistivity values of each layer range from 20 to 30 ohm-m at the first layer and vary ranging from 600 to 700 ohm-m at the second layer, respectively. It can be judged that the first layer, which has from 30 to 50 m in thickness, represents Bs formation (Tertiary basalt) and the second layer indicates P3 formation. On the other hand, resistivity models of B-3 point shows three layers structure. The resistivity of the first and the second layers shows ranging from 10 to 200 ohm-m and that of the third layer indicates 3,500 ohm-m. It can be also judged that the former corresponds to the Bs formation (Tertiary basalt) and the latter shows P3 formation, respectively.

Taking the results of TEM survey into consideration, it is concluded that the Kok-Ing No.2 tunnel passes into the P3 formation, and Bs formation (Tertiary basalt) is not exposed inside this tunnel.

TDEM survey

Resistivity sections by TDEM survey, which are also shown in Figure 11.2.3-16 to 11.2.3-19, were produced by Occam and layered earth inversions for each of the data sets. The survey line coordinate is given on the horizontal axes of the figures and the elevation above sea level is shown on the vertical axes of the plot. The units of these axes are meters and the vertical exaggeration of the plot is one to one. The colour scale to the right of the plot indicates resistivity in Ohm-m. In the above figures, planned tunnel level is also presented in parallel lines. The feature and characteristic of each of the resistivity section confirmed by TDEM survey are as follows.

< *TDEM Survey Line TDEMB 29.4* >

The TDEM survey line TDEMB29.4 is located in the high mountain area, which is composed of Middle to Upper Triassic PRpl (Pa Lae formation which is made up of limestone), around the Kok-Ing No.2 tunnel. This line extends from NNW to SSE direction and is 1.0 km long. On the whole, this line is characterized by the existence of a remarkable high resistivity zone as a whole. (refer to Figure 11.2.3-16)

Layered earth inversion reveals the existence of three layers in total. The resistivity of the first layer ranges from 1,200 to 3,300 ohm-m, and the thickness varies ranging from 150 and 400 m. That of the second layer ranges from 5,500 to 10,000 ohm-m or more and is about 300 m thick. And, that of the third layer shows a range from 800 to 2,000 ohm-m. It is inferred that the resistivity differences of each layer have resulted from the existence of a wide variety of rock qualities and water content of rocks, degree of groundwater movement and so on. Furthermore, the existence of horizontal discontinuity in resistivity, which probably indicates fracture zones caused by faults in limestone, is clarified at No.2,915-2,916 on survey line.

Moreover, according to the Occum's inversion model, at the survey point from 2,094 to 2,194 (EL.100 to EL.450), relatively low resistivity zone of eyeball shape (about 1,000 ohm-m) is recognized. There is a large possibility that this low resistivity zone signify groundwater flow. On the occasion of tunnel construction, special attention should be paid to the presence of both horizontal discontinuity in resistivity and low resistivity zone.

< *TDEM Survey Line TDEMB 30.0* >

The TDEM survey line TDEMB30.0 is also located on the high mountain area, which is composed of Middle to Upper Triassic TRhf (Huai Fak formation which is composed of sandstone, tuff interbedded with slate), along/around the Kok-Ing No.2 tunnel. And, this line is composed of continuous two lines. The first line extends from NW to SE direction and is 1.8 km long along tunnel alignment, and second line direction elongates from NE to SW direction. Furthermore, the two lines cross at about right angle. These lines are also characterized by the presence of high resistivity zone as a whole. (refer to Figure 11.2.3-17)

Resistivity values in this section show an extensive range (100 to 10,000 ohm-m or more). Furthermore, some deep conductive zones reach to about 100 to 200 m in depth at the No.3,012-No.3,016, No.3,036-No.3,037, and No.3,043-No.3,048. However, it is worth noting that the data of this line, in the presence of heterogeneous conductive zone (or body), show reversal transient phenomena. In the case of the presence of clear weak zone between the survey line and transmitter cable, the transient data is sometimes distorted by the secondary magnetic field in the conductive zone. On the other hand, normal transient (not reversal) data was measured between No.3,037 and No.3,048. These matter suggest that clear fractured zone or fault zone crosses the survey line between No.3036 and No.3037 and elongate at the southward area of survey line where reversal transient phenomena is confirmed. Around this area, it should be taken into consideration the direction and characteristic of potential weak zone in the future.

* Reversal transient phenomena ; Transient magnetic field data after shutting off the transmitted current has normally positive polarity. The polarity of transient curve is sometimes changed near conductive (e,g, fracture) in resistive host rock. This is caused by secondary magnetic field induced by eddy current in the conductive zone.

< TDEM Survey Line TDEMB 35.0 >

The TDEM survey line TDEMB35.0 is also situated in the high mountain area, which is composed of Middle to Upper Triassic TRhf (Huai Fak formation which is composed of sandstone, tuff interbedded with slate) at this area, along the Kok-Ing No.2 tunnel. This line extends from NW to SE direction and is 2.0 km long. This line is also characterized by the existence of a remarkable high resistivity zone as a whole. (refer to Figure 11.2.3-18 and 11.2.3-19)

Layered earth inversion revealed the existence of two or four layers. The resistivity of the first layer ranges from 150 to 1,800 ohm-m, and the thickness varies from 200 and 300. That of the second layer ranges from 2,800 to 9,600 ohm-m, and the thickness varies from 100 and 300 m. And, that of the third layer shows ranging from 300 to 1,000 ohm-m, and the thickness varies ranging from 100 and 400 m. That of the fourth layer shows a range from 2,000 to 9,300 ohm-m. It is inferred that these resistivity differences of each layer have resulted from the existence of wide variety of rock qualities and water content of rocks and so on. Furthermore, the existence of horizontal discontinuity in resistivity, which probably indicates fracture zones caused by faults in basement rocks, is clarified at No.3,506-3,507 and No.3612-No.3613, of the survey line. On the occasion of tunnel construction, special attention should be paid in the area between the above two horizontal discontinuities in resistivity because there is a large possibility that this area is in fractured, fissured, jointed and faulted rocks.

The list of tables and figures of this chapter are as follows.

< List of Tables and Figures >

Topographical and Geological Characteristic of Typical Location at the Yao River Training

Topographical and geological characteristics of typical locations for the river training area are as follows. In this case, field reconnaissance survey at this area was performed for the purpose of presentation of basic data on the occasion of study as for river training facilities. The above typical locations are shown in the attached location map.

- Station No.1 (Yot river), coordinate 670,350E, 2,144,050N

Station No.1 is located near the outlet portion of the Ing-Yot No.2 tunnel. In general, topographical condition consists of many small hills, and the Yot river meanders through the foot of these hills. Geological condition is mostly composed of strongly weathered shale of the Triassic-Permian in age. Thick alluvial deposits, which are composed of poorly stratified, coarse sand and gravel layer, distributed in the riverbed of the Yot river.

This area corresponds to the river training place, and it is considered that this area has no serious problem for engineering work from geological viewpoint.

- Station No.2 (Yao river), coordinate 675,700E, 2,150,100N

Station No.2 is located on the Ban Nam Lu. Topographical condition of this area shows V-shaped valley with somewhat steep slope, and hill tribe village and reforested mountain slope spread in the neighboring area. Geological condition of this station is covered by alluvial deposits, which mainly consist of sand and silt, and thickness of this layer is inferred to be 5 m or less.

This area is outside the river training place, however, it is considered that this area has no serious problem as for engineering works.

- Station No.3 (Yao river), coordinate 676,500E, 2,148,700N

Station No.3 is located on the Ban Wang Sa. Topographical and geological conditions of this area are similar to Station No.2.

- Station No.4 (Yao river), coordinate 676,500E, 2,148,700N

Station No.4 is located on the Ban Song Khwae. Topographical condition of this area shows mountainous feature and agricultural field with maize, tobacco and vegetables, extended at the foot of hills. This area is perfectly covered by alluvial deposit (overburden deposit) 5 m or more in thickness approximately.

This area corresponds to the river training place, and it is considered that this area has no serious problem for engineering works.

- Station No.5 (Yao river), coordinate 680,600E, 2,135,000N

Station No.5 is located on the Ban Pang Puk. Topographical condition of this area shows wide terrace feature along the Yao river. In this case, the left-bank side of river is characterized by extremely steep gradient and continues to the residential area. The right-side of that is chiefly underlain by flood plain. Geological condition of this area is covered by alluvial deposits and no outcrop of basement rock.

This area also corresponds to the river training place, and it is considered that this area has no serious problem for engineering works from geological sense

- Station No.6 (Yao river), coordinate 681,350E, 2,133,050N

Station No.6 is located on the point at about 1.5 km downstream of the Ban Pang Puk. Topographical condition of this area shows valley feature accompanying with terrace, which is utilized as cultivated field for cotton and maize etc. in small scale at the both abutments. This area is also covered by alluvial deposit and show not outcrop of basement rock.

This area also corresponds to the river training place, and it is considered that this area has no serious problem for engineering.

- Station No.7 (Yao river), coordinate 683,000E, 2,130,000N

Station No.7 is located on the Ban Sop Pet. Topographical condition of this area is similar to that of Station No.5. The left-bank side of river shows feature with steep gradient while the right-bank side is composed of flood plain, which is cultivated to maize and cotton etc. In this area, detrial rock fragments are frequent found, which are made up of conglomerate and sandstone etc. derived from basement rocks.

Furthermore, topographical features of the left bank suggest potential hazard of mass-wasting in case of a rapid increase of water table.

- Station No.8 (Yao river), coordinate 683,200E, 2,129,300N

Station No.8 is located on the Rong Rian Ban Sop Pet. Topographical condition of this area is characterized by gentle gradient as a whole at the both abutments. The left bank area is the residential area, while the opposite side is utilized for cultivated land. This area is also covered by alluvial deposit, which is inferred as 5 m or more in thickness, and no outcrop of basement rock.

This area has no problem as for engineering works, except for the hazard of small scale as for erosion under the condition of rising of river water.

- Station No.9 (Yao river), coordinate 684,750E, 2,127,950N

Station No.9 is located on the Ban Nam Mong. The topographical condition of this area shows feature of V-shape valley. Geological condition of this area consists of the Triassic-Permian phyllite and schist, which is provided as continuous outcrops at the foot place of the left bank. These basement rocks are overlain by thick alluvial deposits. It is considered that this area has no problems awaiting solution on the basis of geological sense, except for the hazard of small-scale erosion at the both abutments in case of rising of river water.

This area has no problem for engineering works, except for the hazard of small-scale erosion under the condition of rising of river water.

- Station No.10 (Yao river), coordinate 686,500E, 2,121,350N

Station No.10 is located on the Ban Tat. Topographical condition of this area is characterized by wide flood plain, which is utilized as cultivated land for vegetable, tobacco and teak etc. Geological condition of this area consists of strongly weathered shale, which is found at the foot of the left abutment. This basement rock is also covered by thick alluvial deposits.

This area has also no problem as for engineering works from geological sense, except for the hazard of small scale erosion under the condition of rising of river water.

- Station No.11 (Yao river), coordinate 68,300E, 2,119,500N

Station No.11 is located on the downstream about 2 km of the Ban Tat, and corresponds to the DEDP pumping station with floating type. Topographical condition of this area is also characterized by wide flood plain, which is utilized as cultivated land for tobacco. Geological condition of this area is of thick alluvial deposits.

This area has also no problem for engineering works from geological sense, and transportation of existing pumping station should be required as a matter of course.

- Station No.12 (Confluence point of Yao and Nan river), coordinate 690,000E, 2,144,500N

Station No.12 is located on the confluence point of the Yao and the Nan river. Topographical condition around this area shows wide flood plain, which is utilized as cultivated land for a variety of vegetable and tobacco etc. Geological condition of this area is covered by thick alluvial deposits, which are composed of unconsolidated small gravel, sand and silt, and basement outcrops can not be found in provided at this area.

It is considered that there is a potential hazard of increasing erosion at the opposite side of confluence point under conditions of rapid rising river water.

Table 11.2.2-1 Summary of Drilling Results (Clasification of Geological Condition of Each Borehole)

Location	Hole No.	Drilling Depth (m)	Soil (m)	Sandstone (m)	Shale, slate (m)	S.s.&shale slate alt. (m)	Tuff (m)	Phyllite (m)	Limestone (m)	Andesite (m)	Basalt (m)	Porphyry (m)	Others (m)
Kok intake	DHKI-A1	30.0	30.0	---	---	---	---	---	---	---	---	---	---
	DHKI-B1	30.0	30.0	---	---	---	---	---	---	---	---	---	---
Kok-Ing canal route	DHKI-B2	30.0	30.0	---	---	---	---	---	---	---	---	---	---
	DHKI-B7	30.0	20.9	---	---	---	---	---	9.1	---	---	---	---
	DHKI-B8	20.0	20.0	---	---	---	---	---	---	---	---	---	---
	DHKI-B9	20.0	20.0	---	---	---	---	---	---	---	---	---	---
	DKI-2	30.0	30.0	---	---	---	---	---	---	---	---	---	---
	DKI-4	30.0	26.9	3.1	---	---	---	---	---	---	---	---	---
	DKI-5	20.0	11.0	---	---	---	9.0	---	---	---	---	---	---
	DKI-6	20.0	20.0	---	---	---	---	---	---	---	---	---	---
	DKI-7	20.0	20.0	---	---	---	---	---	---	---	---	---	---
	DKI-8	20.0	20.0	---	---	---	---	---	---	---	---	---	---
Kok-Ing canal (south route)	DHKI-B4	30.0	12.1	3.9	---	---	---	---	---	---	---	---	14.0
	DHKI-B5	30.0	17.0	13.0	---	---	---	---	---	---	---	---	---
	DHKI-B6SP	30.0	14.2	---	15.8	---	---	---	---	---	---	---	---
Kok-Ing No.1 tunnel	DHKBJT1-1SP	70.0	7.5	2.2	23.6	---	33.9	---	---	---	---	2.8	---
Kok-Ing No.2 tunnel	DHKB-1	70.0	2.8	---	---	---	21.7	---	44.5	---	1.0	---	---
	DHKB-2	65.0	10.0	---	52.1	---	---	---	---	---	---	---	2.9
	DHK-EXTRA7	50.0	2.2	2.7	36.7	---	7.5	---	---	---	0.9	---	---
Kok-Ing No2. tunnel (B-J route)	DHKBJT2-1	65.0	2.0	---	---	---	1.0	---	---	---	58.4	3.6	---
	DHKBJT2-2	55.0	10.2	---	---	---	44.8	---	---	---	---	---	---
	DHBJ-4.5	165.0	6.2	61.0	84.2	---	---	---	---	13.6	---	---	---
Ing diversion weir	DHID-1	40.0	40.0	---	---	---	---	---	---	---	---	---	---
	DHID-2	40.0	40.0	---	---	---	---	---	---	---	---	---	---
	DHID-3	40.0	40.0	---	---	---	---	---	---	---	---	---	---
Ing - Yot No.1 tunnel	DHIY-1	50.0	4.0	---	---	---	46.0	---	---	---	---	---	---
	DHIY-2	30.0	11.7	---	---	---	18.3	---	---	---	---	---	---
Ing-Yot No.2 tunnel (adit)	DH1AD1	65.0	6.4	10.1	44.7	3.8	---	---	---	---	---	---	---
	DH2AD1SP	90.0	9.0	1.8	58.8	---	20.4	---	---	---	---	---	---
	DH3AD1	60.0	9.1	---	14.6	36.3	---	---	---	---	---	---	---
	DH4AD1	65.0	0.5	34.6	29.9	---	---	---	---	---	---	---	---
	DH5AD1	70.0	4.0	66.0	---	---	---	---	---	---	---	---	---
	DH6AD1SP	120.0	0.7	101.1	2.0	16.2	---	---	---	---	---	---	---
	DH7AD1	60.0	2.0	57.8	---	---	---	---	0.2	---	---	---	---

Table 11.2.2-2 Summary of Drilling Results (Clasification of Geological Condition of Each Borehole)

Location	Hole No.	Drilling Depth (m)	Soil (m)	Sandstone (m)	Shale, slate (m)	S.s.&shale slate alt. (m)	Tuff (m)	Phyllite (m)	Limestone (m)	Andesite (m)	Basalt (m)	Porphyry (m)	Others (m)
Ing-Yot No.2 tunnel	DHB-1	40.0	1.5	---	38.5	---	---	---	---	---	---	---	---
	DHB-2	45.0	6.5	---	38.5	---	---	---	---	---	---	---	---
	DHB-3	55.0	18.5	---	---	---	36.5	---	---	---	---	---	---
	DHB-4	120.0	19.0	65.8	15.2	---	---	---	20.0	---	---	---	---
	DHB-5	120.0	7.0	56.9	54.6	---	---	1.5	---	---	---	---	---
	DHB-6	150.0	7.1	---	---	---	---	---	142.9	---	---	---	---
	DHB-7	60.0	17.7	---	---	---	---	---	42.3	---	---	---	---
	DHB-8	50.0	10.0	---	---	---	40.0	---	---	---	---	---	---
	DHA-1	60.0	1.4	---	---	---	58.6	---	---	---	---	---	---
	DHA-2	70.0	0.5	---	---	---	---	69.5	---	---	---	---	---
	DHB0	35.0	9.2	---	14.3	---	11.5	---	---	---	---	---	---
	DHB0.6	50.0	2.1	24.8	23.1	---	---	---	---	---	---	---	---
	DHB1SP	80.0	4.6	---	---	---	35.6	---	---	---	---	39.8	---
	DHB8SP	145.0	7.5	---	72.8	58.0	4.2	---	---	---	---	---	2.5
	DHBJ-16.5	200.0	1.0	17.5	181.5	---	---	---	---	---	---	---	---
	DHBJ-18.0	205.0	9.7	90.2	73.5	31.6	---	---	---	---	---	---	---
	DHBJ-22.5	220.0	8.0	40.7	171.3	---	---	---	---	---	---	---	---
	DHBJ-26.0	300.0	9.7	---	---	---	290.3	---	---	---	---	---	---
	DHBJ-33.0	310.0	2.5	12.0	5.6	---	289.9	---	---	---	---	---	---
	DHB46SP	100.0	10.7	---	---	---	---	---	89.3				---
	DHB49	60.0	4.0	3.0	53.0	---	---	---	---	---	---	---	---
	DHB50SP	90.0	10.3	0.7	---	79.0	---	---	---	---	---	---	---
Ing-Yot tunnel (south route)	DHC-1	42.0	3.5	9.5	29.0	---	---	---	---	---	---	---	---
	DHC-2	65.0	11.5	28.3	25.2	---	---	---	---	---	---	---	---
Yao flood control dam	DH1	50.0	1.5	4.0	7.0	5.5	32.0	---	---	---	---	---	---
	DH2	80.0	6.1	4.6	2.4	21.0	45.9	---	---	---	---	---	---
	DH3	60.0	4.0	28.6	18.4	9.0	---	---	---	---	---	---	---
	DH4	50.0	5.0	13.0	32.0	---	---	---	---	---	---	---	---
	DH5	30.0	3.3	1.0	11.7	14.0	---	---	---	---	---	---	---
	DH6	30.0	3.0	27.0	---	---	---	---	---	---	---	---	---
Total	64 holes	4,632.0	736.8	784.9	1,230.0	274.4	1,047.1	71.0	348.3	13.6	60.3	46.2	19.4

* Phyllite involves phyllite & sandstone alternation.
* Porphry involve porphylite.
* "Others" is composed of quartzite and conglomarate.
* Siltstone is estimated as shale.

Table11.2.2-3 Summary of Drilling Results (Clasification of Rock Mass Class of Each Borehole)

Location	Hole No.	Drilling Depth (m)	G.H. (m)	Rock Class. Soil	B	CH	CM	CL	D	Water Table (m)	Formation Name	Drilling Year
Kok intake	DHKI-A1	30.0	389	30.0	---	---	---	---	---	2.0	Aluv.& diluv.	1997
	DHKI-B1	30.0	389	30.0	---	---	---	---	---	2.1	Aluv.& diluv.	1997
Kok-Ing canal route	DHKI-B2	30.0	391	30.0	---	---	---	---	---	2.0	Aluv.& diluv.	1997
	DHKI-B7	30.0	397	20.9	---	---	1.0	8.1	---	0	Aluv.& diluv.	1997
	DHKI-B8	20.0	367	20.0	---	---	---	---	---	0	Aluv.& diluv.	1997
	DHKI-B9	20.0	372	20.0	---	---	---	---	---	0.1	Aluv.& diluv.	1997
	DKI-2	30.0	389	30.0	---	---	---	---	---	3.0	Aluv.& diluv.	1997
	DKI-4	30.0	385	26.9	---	---	---	---	3.1	0.5	Aluv.& diluv.	1997
	DKI-5	20.0	386	11.0	---	---	---	---	9.0	2.5	Aluv.& diluv.	1997
	DKI-6	20.0	387	20.0	---	---	---	---	---	2.5	Aluv.& diluv.	1997
	DKI-7	20.0	392	20.0	---	---	---	---	---	1.0	Aluv.& diluv.	1997
	DKI-8	20.0	373	20.0	---	---	---	---	---	0.7	Aluv.& diluv.	1997
Kok-Ing canal (south route)	DHKI-B4	30.0	395	12.1	4.0	5.0	2.0	4.0	2.9	1.3	PTR	1997
	DHKI-B5	30.0	397	17.0	---	---	---	---	13.0	0.6	PTR	1997
	DHKI-B6SP	30.0	397	14.2	---	---	---	---	15.8	0.6	PTR	1997
Kok-Ing No.1 tunnel	DHKBIT1-1SP	70.0	430	7.5	---	14.1	9.0	9.8	29.6	5.5	PTR	1997
Kok-Ing No.2 tunnel	DHKB-1	70.0	436	2.8	---	2.5	15.7	15.9	33.1	15.0	P2, P3	1997
	DHKB-2	65.0	426	10.0	---	7.3	24.2	18.1	5.4	8.0	PTR	1997
	DHK-EXTRA7	50.0	480	3.1	---	---	2.7	---	44.2	---	P3	1998
Kok-Ing No2. tunnel (B-I route)	DHKBIT2-1	65.0	435	2.0	---	40.6	14.2	4.5	3.7	4.0	An	1997
	DHKBIT2-2	55.0	420	10.2	---	---	---	---	44.8	8.0	P3	1997
	DHBJ-4.5	165.0	520	6.2	---	---	29.3	62.3	67.2	36.0	P3	1998
Ing diversion weir	DHID-1	40.0	362	40.0	---	---	---	---	---	1.0	Aluv.& diluv.	1997
	DHID-2	40.0	362	40.0	---	---	---	---	---	0.1	Aluv.& diluv.	1997
	DHID-3	40.0	364	40.0	---	---	---	---	---	0.2	Aluv.& diluv.	1997
Ing -Yot No.1 tunnel	DHIY-1	50.0	394	4.0	---	---	15.2	24.1	6.7	6.5	ms3	1997
	DHIY-2	30.0	373	11.7	---	---	6.0	4.9	7.4	4.0	TRpn	1997
Ing-Yot No.2 tunnel (adit)	DH1AD1	65.0	482	6.4	---	---	15.9	6.0	36.7	44.0	CPhk	1997
	DH2AD1SP	90.0	495	9.0	---	---	7.9	8.7	64.4	5.0	CPhk	1997
	DH3AD1	60.0	530	9.1	---	1.2	16.7	12.4	20.6	20.0	CPnb	1997
	DH4AD1	65.0	535	0.5	---			14.7	49.8	28.5	CPhk, CPnb	1997
	DH5AD1	70.0	550	4.0	---	15.4	27.1	11.9	11.6	27.3	TRhf	1997
	DH6AD1SP	120.0	660	0.7	12.4	42.2	24.8	22.7	17.2	24.3	TRhf	1997
	DH7AD1	60.0	460	2.0		27.0	6.2	7.0	17.8	23.0	TRhf	1997

Table11.2.2-4 Summary of Drilling Results (Clasification of Rock Mass Class of Each Borehole)

Location	Hole No.	Drilling Depth (m)	G.H. (m)	Rock Class. Soil	B	CH	CM	CL	D	Water Table (m)	Formation Name	Drilling Year
Ing-Yot No.2 tunnel	DHB-1	40.0	383	1.5	---	---	22.0	16.5	---	1.3	TRpn	1996
	DHB-2	45.0	388	6.5	---	---	23.0	5.0	10.5	3.1	TRpn	1996
	DHB-3	55.0	402	18.5	---	---	3.0	25.0	8.5	3.1	TRpn	1996
	DHB-4	120.0	463	19.0	---	1.0	17.0	78.5	4.5	4.5	CPhk	1996
	DHB-5	120.0	461	7.0	---	19.0	47.5	45.0	1.5	3.2	CPnb	1996
	DHB-6	150.0	482	7.1	---	28.0	97.0	1.7	16.2	3.1	TRpl	1996
	DHB-7	60.0	383	17.7	19.5	2.5	---	0.4	19.9	3.7	TRpl	1996
	DHB-8	50.0	375	10.0	---	10.5	5.5	4.0	20.0	12.5	TRhf	1996
	DHA-1	60.0	403	1.4	---	12.0	26.6	19.4	0.6	0.9	TRpn	1996
	DHA-2	70.0	412	0.5	---	---	---	19.0	50.5	0.6	CPhk	1996
	DHB0	35.0	382	9.2	---	---		13.5	12.3	1.5	TRpn	1997
	DHB0.6	50.0	390	2.1	---	---	15.3	26.2	6.4	0.7	TRpn	1997
	DHB1SP	80.0	420	4.6	13.4	29.2	11.5	4.1	17.2	22.0	PTRgr	1997
	DHB8SP	145.0	488	7.5	---	---	3.2	61.2	73.1	0.7	CPnb	1997
	DHBJ-16.5	200.0	532	1.0	---	79.7	84.8	31.5	3.0	0.0	CPnb	1998
	DHBJ-18.0	205.0	537	9.7	---	63.2	106.9	24.0	1.2	0.0	CPnb	1998
	DHBJ-22.5	220.0	547	8.0	---	109.6	71.7	25.8	4.9	0.0	CPnb	1998
	DHBJ-26.0	300.0	619	9.7	18.4	223.8	23.9	16.2	8.0	0.0	PTRv	1998
	DHBJ-33.0	310.0	638	2.5	---	49.4	109.1	96.5	52.5	10.5	TRhf	1998
	DHB46SP	100.0	420	10.7	---	25.7	60.5	3.1	---	4.0	TRpl	1997
	DHB49	60.0	390	4.0	---	---	---	---	56.0	2.1	TRhf	1997
	DHB50SP	90.0	420	10.3	---	27.3	17.2	8.6	26.6	15.5	TRhf	1997
Ing-Yot tunnel (south route)	DHC-1	42.0	387	3.5	---	7.0	15.0	14.4	2.1	21.7	TRpn	1996
	DHC-2	65.0	410	11.5	---	11.8	27.2	14.5	---	2.8	ms3	1996
Yan flood control dam	DH1	50.0	322	1.5	---	---	28.3	17.2	3.0	17.8	TRhf	1997
	DH2	80.0	284	6.1	---	---	31.2	35.7	7.0	3.2	TRhf	1997
	DH3	60.0	296	4.0	---	---	16.1	31.8	8.1	13.0	TRhf	1997
	DH4	50.0	331	5.0	---	---	6.9	9.1	29.0	23.0	TRhf	1997
	DH5	30.0	328	3.3	---	---	5.1	14.9	6.7	10.0	TRhf	1997
	DH6	30.0	316	3.0	---	---	6.6	20.2	0.2	2.0	TRhf	1997
Total	64 holes	4,632.0		737.7	67.7	855.0	1,100.0	918.1	953.5			

* Rock mass classification is shown in the main report "Rock mass classification by drilling core observation".

Table11.2.2-5 Results of Standard Penetration Test (1)

	Kok intake								
	DHKI-A1 (30 m)			DHKI-B1 (DKI-1, 30 m)			DKI-2 (30 m)		
	EL.389.0			EL.389.0			EL.389.0		
Water level	GL.-1.95, 16/7/97-27/7/97			GL.-2.10, 29/7/97-5/8/97			GL.-3.00, 21/10/97-23/10/97		
Depth(m)	Original	Revised	USCS	Original	Revised	USCS	Original	Revised	USCS
1	10	10	CL	6	6	SP	8	8	SM
2	10	10	CL	11	11	SP	16	15.5	SM
3	15	15	CL	5	5	SP	19	17	SM
4	6	6	SM	13	13	SP	18	16.5	SM
5	14	14	CL	7	7	SP	19	17	SM
6	11	11	SC	5	5	SP	23	19	SM
7	28	21.5	SP	4	4	SP	15	15	SM
8	26	20.5	SP	17	16	SP	20	17.5	SM
9	27	27	SP	19	17	SP	27	21	SM
10	29	22	SP	18	16.5	SP	27	21	SM
11	40	27.5	SP	19	17	SP	18	16.5	SM
12	41	28	SP	38	26.5	SP	28	21.5	SM
13	25	20	SP	34	24.5	SP	37	26	SM
14	23	19	SP	37	26	SP	39	27	SM
15	31	23	SP	40	27.5	SP	48	31.5	SM
16	29	22	SP	31	23	SP	35	25	SM
17	38	26.5	SP	35	25	SP	50	32.5	SM
18	42	28.5	SP	28	21.5	SP	45	30	SM
19	38	26.5	SP	21	18	SP	48	31.5	SM
20	40	27.5	SP	28	21.5	SP	46	30.5	SM
21	42	28.5	SP	22	18.5	SP	38	26.5	SM
22	38	26.5	SP	25	20	SP	47	31	SM
23	43	29	SP	28	21.5	SP	41	28	SM
24	44	29	SP	17	16	SP	40	27.5	SM
25	41	27.5	SP	23	19	SP	55	34.5	SM
26	47	30.5	SP	30	22	SP	49	31.5	SM
27	63	38.5	SP	30	22	SP	43	28.5	SM
28	95	54	SP	25	19.5	SP	39	26.5	SM
29	86	84	CL	37	25.5	SP	54	34	SM
30			SM			SP			SM

Table11.2.2-6 Results of Standard Penetration Test (2)

	Kok-Ing water diversion canal between Kok intake and No.1 tunnel								
	DHKI-B2 (DKI-3, 30 m)			DKI-4 (20 m)			DKI-5 (20 m)		
	EL.391.0			EL.385.0			EL.386.0		
Water level	GL.-2.00, 28/8/97-3/9/97			GL.-0.50, 29/10/97-2/11/97			GL.-2.50, 25/10/97-28/10/97		
Depth(m)	Original	Revised	USCS	Original	Revised	USCS	Original	Revised	USCS
1	5	5	ML	9	9	CH	7	7	SM
2	12	12	ML	8	8	CH	18	18	CH
3	16	16	CL	26	26	CH	23	23	CH
4	17	17	CL	14	14	CH	16	16	CH
5	16	16	CH	15	15	CH	20	20	CH
6	25	25	CH	25	25	CH	15	15	CH
7	21	21	CH	8	8	SM	32	32	CH
8	28	28	CH	15	15	SM	27	27	CH
9	31	31	CH	6	6	CH	18	18	CH
10	34	34	CH	10	10	CH	47	47	CH
11	37	37	CH	27	21	SM			Tuff
12	42	42	CH	30	22.5	SM			Tuff
13	41	41	CH	46	46	CL			Tuff
14	46	46	CH	29	29	CL			Tuff
15	47	47	CH	27	27	CL			Tuff
16	48	48	CH	15	15	CL			Tuff
17	45	45	CH	16	16	CL			Tuff
18	45	45	CH	16	16	CL			Tuff
19	49	49	CH	23	23	CL			Tuff
20	48	48	CH	32	32	CL			Tuff
21	53	53	CH	31	31	CL			
22	76	45.5	SC	30	30	CL			
23	71	42.5	SC	64	63	CL			
24	73	43.5	SC	61	60	CL			
25	79	46.5	SC	68	67	CL			
26	94	53.5	SC			Sandstone			
27	86	49.5	SC			Sandstone			
28	92	52.5	SC			Sandstone			
29	94	53	SC			Sandstone			
30	94	53	SC			Sandstone			

Table11.2.2-7 Results of Standard Penetration Test (3)

	Kok-Ing water diversion canal between No.1 tunnel and No.2 tunnel								
	DKI-6 (20 m)			DKI-7 (20 m)			DHKI-B7 (30 m)		
	EL.387.0			EL.392.0			EL.397.0		
Water level	GL.-2.50, 18/10/97-19/10/97			GL.-1.00, 28/10/97-29/10/97			GL.-0.0, 14/8/97-22/8/97		
Depth(m)	Original	Revised	USCS	Original	Revised	USCS	Original	Revised	USCS
1	7	7	CH	7	7	CL	6	6	CL
2	13	13	CH	12	12	CL	6	6	CL
3	14	14	CH	9	9	CL	6	6	CL
4	9	9	CH	34	34	CL	8	8	CL
5	5	5	CL	47	47	CL	8	8	CL
6	2	2	CL	41	41	CL	8	8	CL
7	2	2	CH	33	33	CL	7	7	CL
8	2	2	CH	26	26	CL	9	9	CL
9	2	2	CH	35	35	CL	10	10	CL
10	2	2	CH	14	14	CL	19	19	CL
11	13	13	CH	17	17	CL	13	13	CL
12	8	8	SM	8	8	CL	11	11	CL
13	22	18.5	SM	8	8	CL	13	13	CL
14	25	20	SM	18	18	CL	9	9	CL
15	14	14	CH	29	29	CL	12	12	CL
16	14	14	CH	23	23	CL	15	15	CL
17	25	25	CH	33	33	CL	1	1	CL
18	29	29	CH	26	26	CL	2	2	CL
19	50	50	CH	35	35	CH	1	1	CL
20			CH			CH	2	2	CL
21							50/5cm	100	Limestone
22									Limestone
23									Limestone
24									Limestone
25									Limestone
26									Limestone
27									Limestone
28									Limestone
29									Limestone
30									Limestone

Table11.2.2-8 Results of Standard Penetration Test (4)

	Kok-Ing water diversion canal between No.2 tunnel and Ing weir								
	DKI-8 (20 m)			DHKI-B8 (20 m)			DHKI-B9 (DKI-9, 20 m)		
	EL.373.0			EL.367.0			EL.372.0		
Water level	GL.-0.70, 13/10/97-14/10/97			GL.-0.00, 31/8/97-7/9/97			GL.-0.08, 25/9/97-28/9/97		
Depth(m)	Original	Revised	USCS	Original	Revised	USCS	Original	Revised	USCS
1	9	9	CH	5	5	CL	16	16	CL
2	20	20	CH	7	7	CL	28	28	CL
3	28	28	CH	16	16	CL	35	35	CL
4	27	27	CH	23	23	CL	22	22	CL
5	22	22	CH	23	23	CL	30	30	CL
6	20	20	CH	36	36	CL	22	22	CL
7	19	19	CH	31	31	CL	80	80	CL
8	10	10	CH	62	62	CL	53	53	CL
9	18	18	CH	33	33	CL	53	53	CL
10	20	20	CH	23	23	CL	49	49	CL
11	17	17	CH	22	22	CL	57	57	CL
12	22	22	CH	29	29	CL	48	48	CL
13	29	29	CH	28	28	CL	43	43	CL
14	20	20	CH	39	39	CL	51	51	CL
15	20	17.5	SC	15	15	CL	58	58	CL
16	28	21.5	SC	20	20	CL	48	48	CL
17	23	19	SC	22	22	CL	80	80	CL
18	13	13	SC	40	40	CL	90	90	CL
19	18	17	SM	31	31	CL	65	65	CL
20	27	27	CH			CL	50/15cm	100	CL

Table11.2.2-9 Results of Standard Penetration Test (5)

	Ing weir								
	DHID-1 (40 m)			DHID-2 (40 m)			DHID-3 (40 m)		
	EL.362.0			EL.362.0			EL.364.0		
Water level	GL.-1.00, 20/9/97-26/9/97			GL.-0.10, 20/9/97-29/9/97			GL.-0.20, 15/9/97-1/10/97		
Depth(m)	Original	Revised	USCS	Original	Revised	USCS	Original	Revised	USCS
1	16	16	CL	35	35	CL	27	27	CL
2	20	20	CL	32	32	CL	20	20	CH
3	19	19	CL	28	28	CL	21	21	CH
4	24	24	CL	16	16	CL	19	19	CH
5	17	16	SM	21	21	CL	10	10	CL
6	13	13	SM	16	15.5	SM	25	25	CH
7	32	23.5	SM	15	15	SM	30	30	CH
8	14	14	SM	30	22.5	SM	41	41	CH
9	10	10	CL	35	25	SM	33	33	CH
10	18	16.5	SM	38	26.5	SM	37	37	CH
11	31	23	SM	45	30	SM	49	49	CH
12	19	17	SM	47	31	SM	59	37	SP
13	23	19	SM	48	31.5	SM	76	45.5	SP
14	25	20	SM	41	28	SM	50/15cm	57.5	GP
15	32	23.5	SM	34	24.5	SM	80	47.5	SP
16	33	24	SM	39	27	SM	50/15cm	57.5	SP
17	23	19	SM	42	28.5	SM	50/10cm	82.5	SP
18	25	20	SM	46	30.5	SM	50/15cm	57.5	SP
19	31	23	SM	37	26	SM	83	49	SC
20	40	27.5	SM	38	26.5	SM	50/15cm	57.5	SC
21	29	22	SM	36	25.5	SM	50/10cm	82.5	SM
22	35	25	SM	41	28	SM	50/10cm	82	SM
23	24	19.5	SM	42	28.5	SM	50/10cm	82	SM
24	32	23.5	SM	45	29.5	SM	50/15cm	57	SM
25	40	27	SM	37	25.5	SM	10/0cm	100	SM
26	40	27	SM	40	27	SM	10/0cm	100	SP
27	48	31	SM	45	29.5	SM	50/15cm	56.5	SP
28	34	24	SM	42	28	SM	50/15cm	56.5	SP
29	37	25.5	SM	48	31	SM	50/10cm	80.5	SP
30	49	31.5	SM	46	30	SM	50/15cm	56	SP
31	41	27.5	SM	40	27	SM	50/15cm	56	SP
32	49	31	SM	44	28.5	SM	50/15cm	55.5	SP
33	45	29	SM	44	28.5	SM	50/10cm	79.5	SP
34	57	35	SM	60	36	SM	50/10cm	79.5	SP
35	60	36	SM	66	39	SM	50/15cm	55.5	SP

<Continued on the right side sheet>

Table11.2.2-10 Results of Standard Penetration Test (6)

	Kok-Ing water diversion canal, south route								
	DHKI-B4 (30 m)			DHKI-B5 (30 m)			DHKI-B6SP (30 m)		
	EL.395.0			EL.397.0			EL.397.0		
Water level	GL.-1.29, 31/7/97-9/8/97			GL.-0.60, 11/8/97-18/8/97			GL.-0.63, 21/8/97-8/9/97		
Depth(m)	Original	Revised	USCS	Original	Revised	USCS	Original	Revised	USCS
1	9	9	CL	3	3	ML	12	12	CL
2	7	7	CL	13	13	CL	10	10	CH
3	4	4	CL	17	17	CL	22	22	CH
4	5	5	CL	22	22	CL	26	26	CH
5	27	27	CL	7	7	SC	16	16	CH
6	41	28	SM	6	6	SC	12	12	CH
7	46	30.5	SM	4	4	SC	17	17	CH
8	43	29	SM	2	2	SC	16	16	CH
9	40	27.5	SM	8	8	SC	15	15	CH
10	36	36	CL	35	25	SM	23	23	CH
11	38	26.5	SM	44	29.5	SM	22	22	CH
12	50/8cm	100	CL	40	27.5	SP	60	60	CH
13			Sandstone	43	29	SC	46	46	CL
14			Sandstone	45	30	SP	50/5cm	100	CL
15			Sandstone	47	31	SP			Shale
16			Sandstone	78	46.5	SP			Shale
17			Sandstone	50/15cm	57.5	SP			Shale
18			Sandstone			Sandstone			Shale
19			Conglo.			Sandstone			Shale
20			Conglo.			Sandstone			Shale
21			Conglo.			Sandstone			Shale
22			Conglo.			Sandstone			Shale
23			Conglo.			Sandstone			Shale
24			Conglo.			Sandstone			Shale
25			Conglo.			Sandstone			Shale
26			Conglo.			Sandstone			Shale
27			Conglo.			Sandstone			Shale
28			Conglo.			Sandstone			Shale
29			Conglo.			Sandstone			Shale
30			Conglo.			Sandstone			Shale
36	61	36.5	SM	70	41	SM	80	45.5	SP
37	62	37	SM	72	41.5	SM	50/15cm	55	SP
38	63	37.5	SM	75	43	SM	50/15cm	55	SP
39	70	40.5	SM	75	43	SM	50/15cm	54.5	SP
40			SM			SM	50/15cm	54.5	SP

Table11.2.2-11 Results of Standard Penetration Test (7)

	Ing-Yot canal		
	DHB0 (30 m)		
	EL.382.0		
Water level	GL.-1.50, 13/9/97-20/9/97		
Depth(m)	Original	Revised	USCS
1	4	4	CL
2	5	5	CL
3	6	6	CL
4	7	7	CL
5	19	19	CL
6	7	7	CL
7	17	17	CL
8	70	42.5	SC
9	50/5cm	100	SC
10			Shale
11			Shale
12			Shale
13			Shale
14			Shale
15			Shale
16			Shale
17			Tuff
18			Tuff
19			Tuff
20			Tuff
21			Tuff
22			Tuff
23			Tuff
24			Tuff
25			Tuff
26			Tuff
27			Tuff
28			Tuff
29			Shale
30			Shale
31			Shale
32			Shale
33			Shale
34			Shale
35			Shale

* Original : Original N-value

* Revised : Revised N-value, revised formulas are as follows.

Revision by depth : $N' = N$ (in case of $L < 20$ m), $N' = (1.06 - 0.003\ L)\ N$ (in case of $L > 20$m)

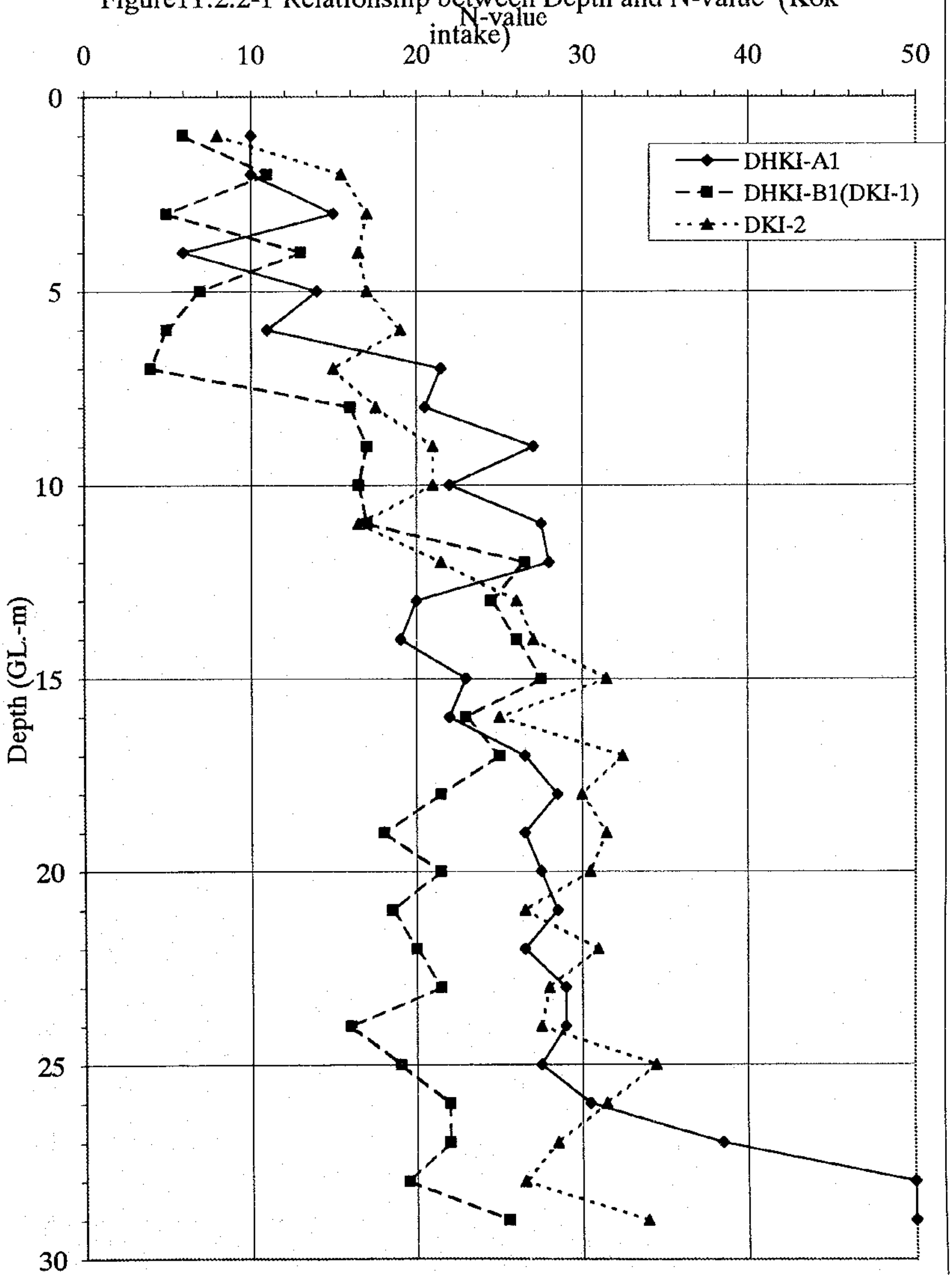
Revision for measured N-value at sand layer (by Terzaghi-Peck)

$N = (N - 15) / 2 + 15$ (in case of $N > 15$)

* USCS : Unified soil classification system

- SP : Poorly graded sands, gravelly sands
- SM : Silty sand, sand-silt mixtures
- SC : Clayey sands, sand-silt mixtures
- GP : Poorly graded gravels, gravel-sand mixtures
- CH : Inorganic clays of high plasticity, fat clays
- CL : Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
- ML : Inorganic silts and very fine sands, silty or clayey fine sands, or clayey silts, with slight plasticity

Figure11.2.2-1 Relationship between Depth and N-value (Kok intake)



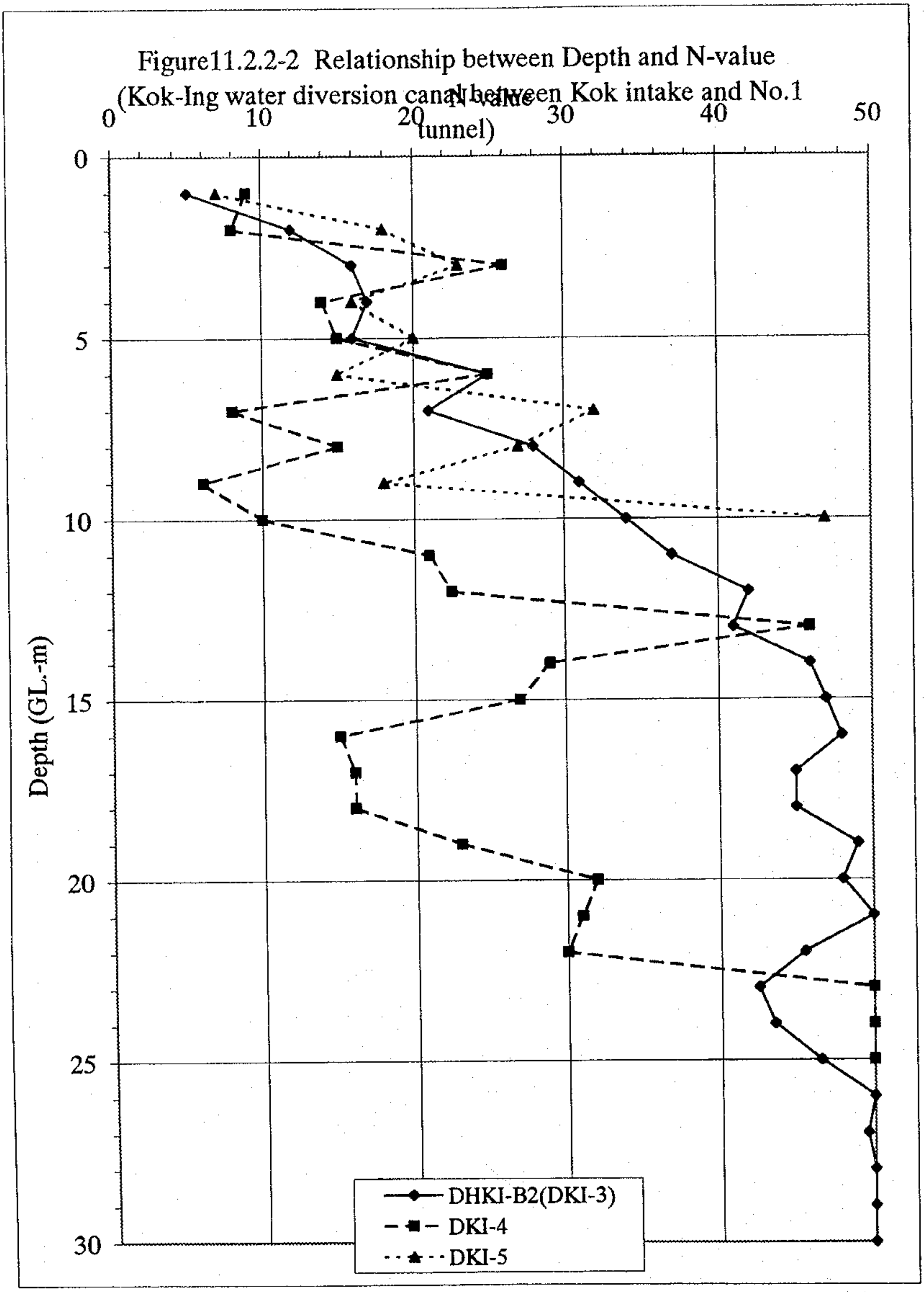


Figure11.2.2-2 Relationship between Depth and N-value
(Kok-Ing water diversion canal between Kok intake and No.1 tunnel)
N-value
0
10
20
30
40
50
Depth (GL.-m)
0
5
10
15
20
25
30
DHKI-B2(DKI-3)
DKI-4
DKI-5

Figure11.2.2-3 Relationship between Depth and N-value (Kok-Ing water diversion canal between No.1 tunnel and No.2 tunnel)

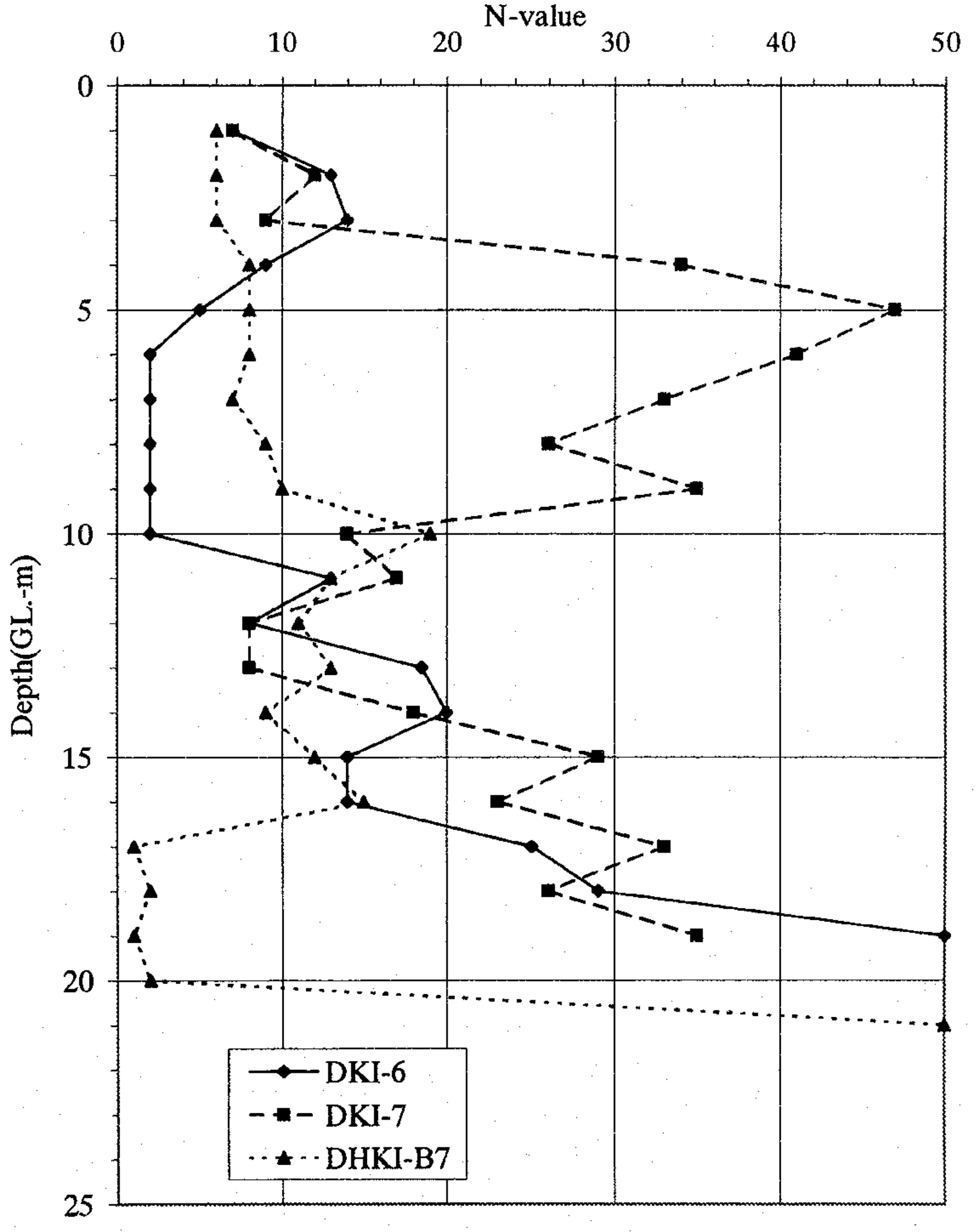


Figure11.2.2-4 Relationship between Depth and N-value (Kok-Ing water diversion canal between No.2 tunnel and Ing weir)

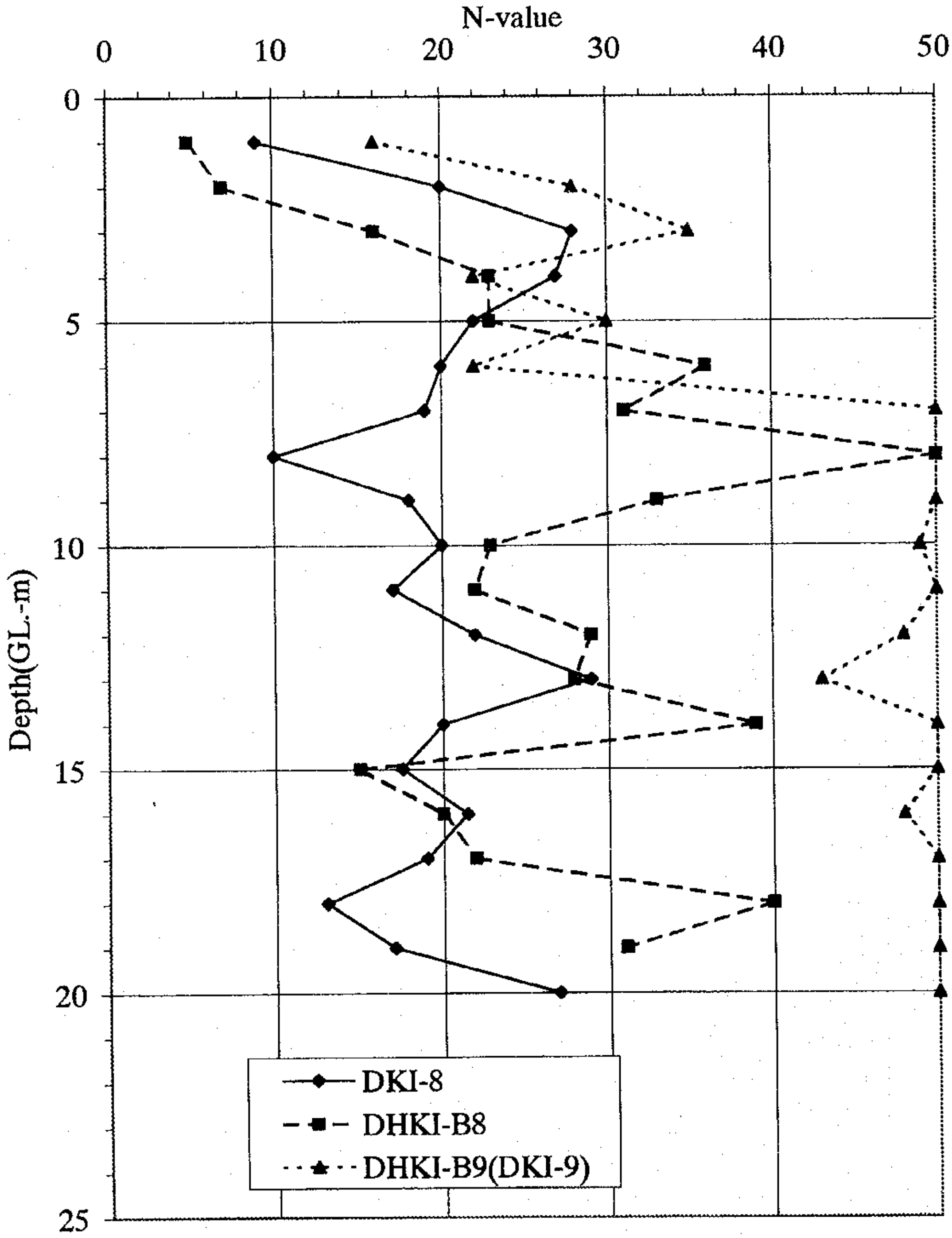


Figure11.2.2-5 Relationship between Depth and N-value
(Ing weir)

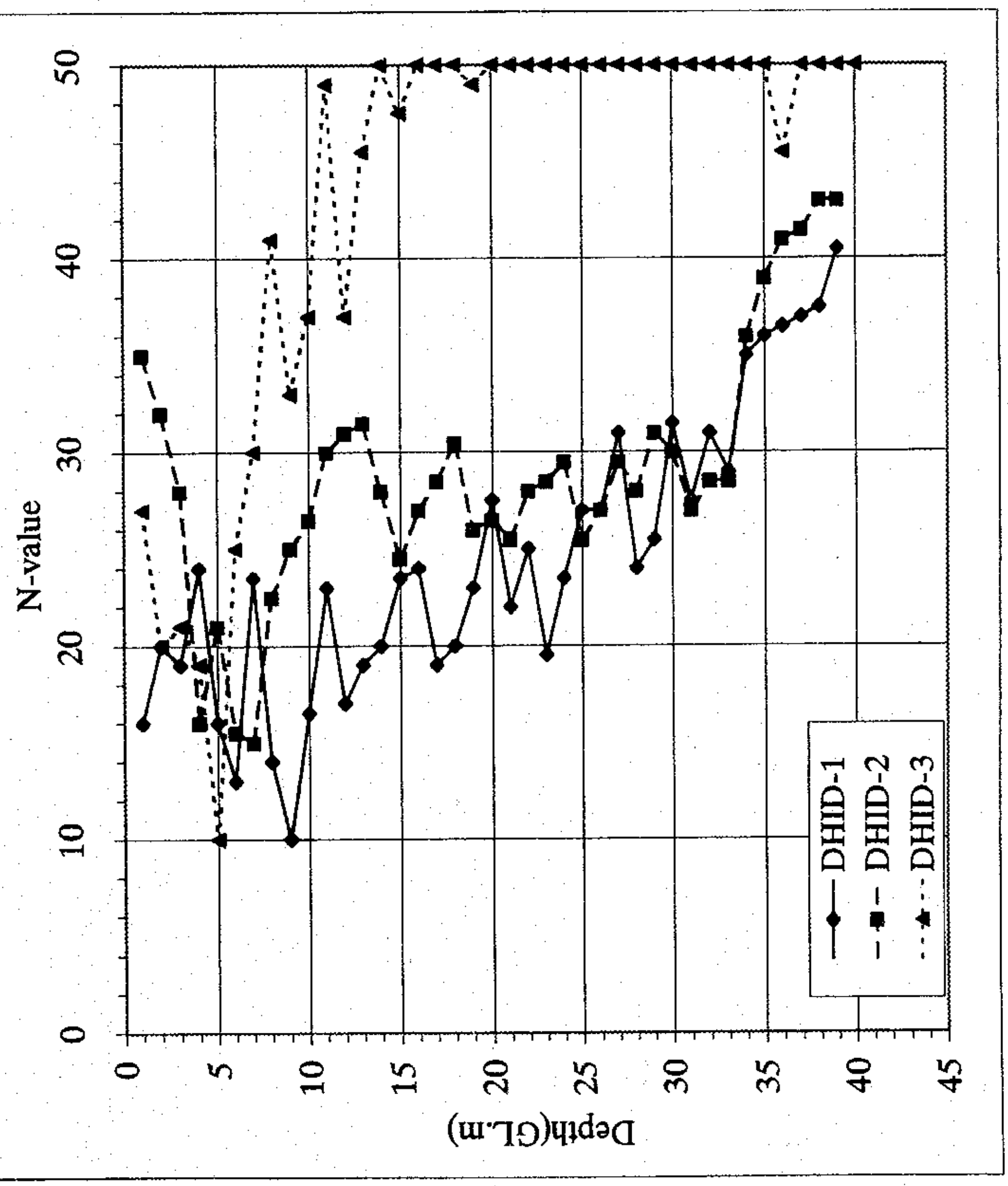


Table11.2.2-12 Results of Lugeon Test (1)

Location	Borehole No.	Borehole G.H. (EL.m)	Testing Depth (m) From	Testing Depth (m) To	Testing Depth (EL.m) From	Testing Depth (EL.m) To	Max. Water Press. (kgf/cm²)	Lugeon Value	Water Table (GL.-m)	Testing Date	Boring Core Condition Form. Name	Boring Core Condition Geology	Rock. Class.
Kok-Ing No.2 tunnel	DHKB-1	436	55	60	381	376	13.6	8.4	15.0	30/8/97	P3,P2	Limestone	CL, CM
		436	60	65	376	371	13.6	4.7	15.0	31/8/97		Limestone	D, CL
		436	65	70	371	366	13.6	12.9	15.0	31/8/97		Limestone	D, CL
	DHKB-2	426	50	55	376	371	12.9	8.2	8.0	28/7/97	PTR	Shale	CL, CM
		426	55	60	371	366	12.9	12.9	8.0	31/7/97		Shale	CL
		426	60	65	366	361	12.9	7.7	8.0	1/8/97		Shale	CL, CH
	DHB-EXTRA7	480	35	40	445	440	6.3	10.7	-	24/4/98	P3	Shale,Tuff	D
	(JICA)	480	40	45	440	435	14.3	0.6	-	26/4/98		Shale,Tuff	D
		480	45	50	435	430	4.8	56.6	-	26/4/98		S.s., Tuff	CM, D
Kok-Ing No.2 tunnel (JICA route)	DHKJT2-1	435	50	55	385	380	12.5	8.3	4.0	18/8/97	An	Basalt	CH
		435	55	60	380	375	12.5	6.9	4.0	18/8/97		Basalt	CH
		435	60	65	375	370	12.5	4.9	4.0	18/8/97		Basalt	CM, CH
	DHKJT2-2	420	40	45	380	375	10.9	7.6	8.0	13/9/97	P3	Tuff	D
		420	45	50	375	370	12.4	11.7	8.0	13/9/97		Tuff	D
		420	50	55	370	365	12.9	8.0	8.0	14/9/97		Tuff	D
	DHBJ4-5	521	125	130	396	391	11.6	2.2	35.0	20/2/98	P3	Shale, Andesite	CL, D
	(JICA)	521	130	135	391	386	4.3	0.9	37.5	21/2/98		Shale, Andesite, S.s.	CL, CM
		521	135	140	386	381	6.1	0.6	45.0	22/2/98		Andesite, S.s., Shale	CL, CM
		521	140	145	381	376	14.6	0.0	45.0	23/2/98		Andesite, Shale	CM, CL
		521	145	150	376	371	14.3	0.1	42.5	24/2/98		Andesite	CM, CL
		521	150	155	371	366	14.1	0.0	40.0	25/2/98		S.s., Andesite	CM, D
		521	155	165	366	356	10.2	0.1	1.7	16/3/98		S.s., Shale	CL, CM
Ing-Yot No.1 tunnel	DHIY-1	394	30	35	364	359	8.7	11.2	6.5	20/7/97	ms3	Tuff	CL
		394	35	40	359	354	9.7	14.4	6.5	21/7/97		Tuff	CM, CL
		394	40	45	354	349	10.7	5.8	6.5	21/7/97		Tuff	CM
		394	45	50	349	344	12.2	8.1	6.5	21/7/97		Tuff	CL
	DHIY-2	373	15	20	358	353	5.0	3.0	4.0	7/9/97	TRpn	Tuff	D, CL
		373	20	25	353	348	6.5	3.5	4.0	8/9/97		Tuff	CM, CL
		373	25	30	348	343	3.0	57.4	4.0	8/9/97		Tuff	CL, CM
Ing-Yot No.2 tunnel (Adit)	DH1AD1	482	50	55	432	427	11.5	3.5	44.0	15/7/97	CPhk	Shale	CM, CL
		482	55	60	427	422	11.5	3.9	44.0	15/7/97		Shale	CM, CL
		482	60	65	422	417	16.5	2.0	44.0	16/7/97		Shale	CL, CM
	DH3AD1	530	45	50	485	480	13.6	0.3	20.0	1/9/97	CPnb	Shale	CL, CM
		530	50	55	480	475	14.1	0.6	20.0	2/9/97		Shale	CM, CL
		530	55	60	475	470	14.1	0.3	20.0	3/9/97		Shale	CM, CH

Table11.2.2-13 Results of Lugeon Test (2)

Location	Borehole No.	Borehole G.H. (EL.m)	Testing Depth (m) From	Testing Depth (m) To	Testing Depth (EL.m) From	Testing Depth (EL.m) To	Max. Water Press. (kgf/cm²)	Lugeon Value	Water Table (GL.-m)	Testing Date	Boring Core Condition Form. Name	Boring Core Condition Geology	Rock. Class.
Ing-Yot No.2 tunnel (Adit)	DH4AD1	535	50	55	485	480	14.9	5.1	28.5	11/9/97	CPhk, CPnb	Sandstone	D
		535	55	60	480	475	14.9	5.2	28.5	14/9/97		Sandstone	CL, D
		535	60	65	475	470	14.9	4.7	28.5	15/9/97		Sandstone	CL
	DH5AD1	550	55	60	495	490	5.8	26.0	27.3	29/6/97	TRhf	Sandstone	CM, CL
		550	60	65	490	485	7.8	11.3	27.3	29/6/97		Sandstone	CM, CL
		550	65	70	485	480	7.8	14.8	27.3	29/6/97		Sandstone	CM, CL
	DH6A1DSP	660	90	95	570	565	2.5	-	24.3	19/8/97	TRhf	Sandstone	CM, B
		660	95	100	565	560	2.5	-	24.3	19/8/97		Sandstone	CH, CM, CL
		660	100	105	560	555	14.5	1.4	24.3	19/8/97		Sandstone	B, CH, D
		660	105	110	555	550	14.5	0.7	24.3	19/8/97		Sandstone	CH, CM, CL, D
		660	110	115	550	545	14.5	0.4	24.3	20/8/97		Sandstone	CH, CM, CL
		660	115	120	545	540	14.5	0.4	24.3	20/8/97		Sandstone	B, CH
	DH7AD1	460	45	50	415	410	13.9	1.1	23.0	23/8/97	TRhf	Sandstone	CH, CM
		460	50	55	410	405	14.4	1.3	23.0	24/8/97		Sandstone	CH
		460	55	60	405	400	14.4	0.6	23.0	25/8/97		Sandstone	CH
Ing-Yot No.2 tunnel	DHA-1	403	45	50	358	353	11.1	0.6	0.9	25/5/96	TRpn	Tuff	CL, CM
		403	50	55	353	348	12.2	0.6	0.9			Tuff	CL, CM
		403	55	60	348	343	13.4	0.9	0.9			Tuff	CM, CL
	DHA-2	412	55	60	357	352	13.4	0.8	0.6	21/6/96	CPhk	Phyllite	D
		412	60	65	352	347	14.3	0.5	0.6			Phyllite	D
		412	65	70	347	342	15.7	0.3	0.6			Phyllite	D
	DHB-1	383	25	30	358	353	6.5	4.3	1.3	5/6/96	TRpn	Shale	CL, CM
		383	30	35	353	348	8.3	4.1	1.3			Shale	CM, CL
		383	35	40	348	343	9.4	3.0	1.3			Shale	CM, CL
	DHB-2	388	30	35	358	353	7.7	4.2	1.3	30/5/96	TRpn	Shale	CM, CL
		388	35	40	353	348	8.8	3.8	1.3			Shale	D
		388	40	45	348	343	10.0	1.6	1.3			Shale	D
	DHB-3	402	40	45	362	357	10.6	4.2	3.1	21/8/96	TRpn	Tuff	CL
		402	45	50	357	352	11.9	5.0	3.1			Tuff	CL
		402	50	55	352	347	13.1	3.1	3.1			Tuff	CL
	DHB-4	463	105	110	358	353	15.5	1.2	4.5	20/5/96	CPhk	Limestone, S.s..	CM
		463	110	115	353	348	15.5	3.8	4.5			Sandstone	CL
		463	115	120	348	343	15.5	2.6	4.5			S.s., limestone	CL
	DHB-5	461	105	110	356	351	15.4	1.5	3.2	26/6'96	CPnb	S.s., Slate	CM, CL
		461	110	115	351	346	15.4	1.8	3.2			Slate	CM
		461	115	120	346	341	15.4	1.3	3.2			Slate	CH

Table11.2.2-14 Results of Lugeon Test (3)

Location	Borehole No.	Borehole G.H. (EL.m)	Testing Depth (m) From	Testing Depth (m) To	Testing Depth (EL.m) From	Testing Depth (EL.m) To	Max. Water Press. (kgf/cm^2)	Lugeon Value	Water Table (GL.-m)	Testing Date	Boring Core Condition Form. Name	Boring Core Condition Geology	Rock. Class.
Ing-Yot No.2 tunnel	DHB-6	482	135	140	347	342	15.4	1.5	3.1	6/8/96	TRpl	Limestone	CM
		482	140	145	342	337	4.4	7.1	3.1			Limestone	CM
		482	145	150	337	332	15.4	2.8	3.1			Limestone	CM
	DHB-7	383	45	50	338	333	11.4	2.6	3.7	12/5/96	TRpl	Limestone	B
		383	50	55	333	328	12.5	1.4	3.7			Limestone	B
		383	55	60	328	323	13.6	2.7	3.7			Limestone	B
	DHB-8	375	35	40	340	335	10.5	5.4	12.5	26/5/96	TRhf	Tuff	CM, CL, CH
		375	40	45	335	330	11.7	3.9	12.5			Tuff	CH
		375	45	50	330	325	12.8	3.7	12.5			Tuff	CH
	DHB0	382	20	25	362	357	6.2	0.6	1.5	18/9/97	TRpn	Tuff	CL, D
		382	25	30	357	352	7.2	2.8	1.5	19/9/97		Tuff, Shale	CL, D
		382	30	35	352	347	8.2	4.6	1.5	20/9/97		Shale	CL, D
	DHB0.6	390	35	40	355	350	9.1	1.3	0.7	8/9/97	TRpn	Shale	CM, CL
		390	40	45	350	345	10.1	1.6	0.7	9/9/97		Shale	CL, D
		390	45	50	345	340	11.6	1.5	0.7	10/9/97		S.s., shale	CM, D, CL
	DHB8SP	488	115	120	373	368	5.1	12.7	0.7	11/7/97	CPnb	S.s. & Shale alt.	D, CL
		488	120	125	368	363	5.1	12.3	0.7	12/7/97		S.s. & Shale alt.	D, CL
		488	125	130	363	358	12.1	0.4	0.7	12/7/97		S.s. & Shale alt., Tuff	CL, D
		488	130	135	358	353	12.1	0.5	0.7	13/7/97		S.s. & Shale alt., Tuff	CL, D
		488	135	140	353	348	12.1	0.2	0.7	13/7/97		S.s. & Shale alt.	CL, D
		488	140	145	348	343	12.1	0.7	0.7	14/7/97		S.s. & Shale alt.	CL, D
	DHB49	390	45	50	345	340	5.3	14.1	2.1	27/6/97	TRhf	Shale	D
		390	50	55	340	335	6.3	20.4	2.1	27/6/97		Shale	D
		390	55	60	335	330	6.3	17.2	2.1	28/6/97		Shale	D
	DHBJ16.5	532	160	165	372	367	10.1	0.2	0.0	19/3/98	CPnb	Slate	CH, CM
	(JICA)	532	165	170	367	362	10.1	0.3	0.0	20/3/98		Slate	CM, CH
		532	170	175	362	357	10.1	1.3	0.0	21/3/98		Slate	CM, CL
		532	175	180	357	352	10.1	0.2	0.0	22/3/98		Slate	CH, CM
		532	180	185	352	347	10.1	1.0	0.0	23/3/98		Slate	CH, CM
		532	185	190	347	342	10.1	0.4	0.0	24/3/98		S.s., Slate	CM, CH
		532	190	200	342	332	10.1	0.0	0.0	25/3/98		Slate	CH, CM

Table11.2.2-15 Results of Lugeon Test (4)

Location	Borehole No.	Borehole G.H. (EL.m)	Testing Depth (m)		Testing Depth (EL.m)		Max. Water Press. (kgf/cm²)	Lugeon Value	Water Table (GL.-m)	Testing Date	Boring Core Condition		Rock. Class.
			From	To	From	To					Form. Name	Geology	
Ing-Yot No.2 tunnel	DHBJ18.0	537	165	170	372	367	10.5	0.3	4.0	18/3/98	CPnb	Slate, S.s.	CM, CH
	(JICA)	537	170	175	367	362	10.1	2.2	0.0	22/3/98		S.s., Slate	CM
		537	175	180	362	357	10.1	0.5	0.0	23/3/98		Sandstone	CH, CM
		537	180	185	357	352	10.1	19.9	0.0	24/3/98		Slate, S.s.	CM, CL, CH
		537	185	190	352	347	8.1	4.5	0.0	25/3/98		Sandstone	CH, CM
		537	190	195	347	342	10.1	0.9	0.0	26/3/98		Sandstone	CM
		537	195	205	342	332	10.1	0.3	0.0	28/3/98		Sandstone	CM, CH
	DHBJ22.5	547	175	180	372	367	10.1	0.6	0.0	28/2/98	CPnb	Slate, S.s.	CH, CM
	(JICA)	547	180	185	367	362	10.1	0.5	0.0	1/3/98		Slate	CM, CH
		547	185	190	362	357	10.1	0.5	0.0	2/3/98		Slate	CM, CH
		547	190	195	357	352	10.1	0.6	0.0	3/3/98		Slate	CH, CM
		547	195	200	352	347	10.1	0.0	0.0	4/3/98		Slate, S.s.	CM, CH
		547	200	205	347	342	10.1	0.0	0.0	5/3/98		Sandstone	CH
		547	205	220	342	327	10.1	0.0	0.0	8/3/98		Sandstone	CH
	DHBJ26.0	619	253	258	366	361	10.1	0.4	0.0	27/2/98	PTRv	Tuff	CH, B
	(JICA)	619	258	263	361	356	10.1	0.4	0.0	1/3/98		Tuff, Dacite	CH, B
		619	263	268	356	351	10.1	0.4	0.0	2/3/98		Tuff	CH, B
		619	268	273	351	346	10.1	0.4	0.0	3/3/98		Tuff	CH
	DHBJ33.0	638	270	275	368	363	6.8	0.2	7.3	9/2/98	TRhf	Tuff	CH, CM
	(JICA)	638	275	280	363	358	8.8	0.3	7.5	10/2/98		Tuff	CH, CM
		638	280	285	358	353	6.8	0.4	7.5	12/2/98		Tuff	CH, CM, CL
		638	285	290	353	348	6.9	0.6	8.2	13/2/98		Tuff	CH, CM
		638	290	295	348	343	8.8	0.8	17.2	14/2/98		Tuff	CH
		638	295	300	343	338	11.5	0.3	44.0	16/2/98		Tuff	CH
		638	300	310	338	328	10.1	0.1	10.5	18/2/98		Tuff	CH, B, CM
Ing-Yot No.2 tunnel (south route)	DHC-1	387	27	32	360	355	9.0	3.1	21.7	12/5/96	TRpn	Siltstone	CM, CH, CL
		387	32	37	355	350	10.7	3.8	21.7			Siltstone, S.s.	CM, CH, CL
		387	37	42	350	345	11.2	2.7	21.7			Sandstone	CM, CL, CH
	DHC-2	410	50	55	360	355	13.5	2.5	2.8	16/7/96	ms3	Sandstone	CM, CL
		410	55	60	355	350	13.5	3.5	2.8			Sandstone	CL, CM
		410	60	65	350	345	14.7	3.7	2.8			S.s., shale	CL, CM

Table11.2.2-16 Results of M.H.T.

Location	Borehole No.	Borehole G.H. (EL.m)	Testing Depth (m) From	Testing Depth (m) To	Testing Depth (EL.m) From	Testing Depth (EL.m) To	Lugeon Value	Water Table (GL.-m)	Boring Core Condition Form. Name	Boring Core Condition Geology	Rock. Class.
Kok-Ing tunnel (South route)	DHKIB6SP	397	10	15	387	382	>50.0	0.6	PTR	Soil, shale	D
		397	15	20	382	377	11.6	0.6		Shale	D
		397	20	25	377	372	18.5	0.6		Shale	D
		397	25	30	372	367	2.2	0.6		Shale	D
Ing-Yot No.2 tunnel (Adit)	DH2Ad1SP	495	70	75	425	420	0.4	5.0	CPhk	Shale	D, CL
		495	75	80	420	415	0.3	5.0		Shale	CM, CL
		495	79	84	416	411	0.3	5.0		Shale	CM, CL
		495	85	90	410	405	0.9	5.0		Shale	CL
	DH3Ad1	530	40	45	490	485	5.5	20.0	CPnb	Shale	CM, D
		530	45	50	485	480	9.0	20.0		Shale	CL, CM
		530	50	55	480	475	3.9	20.0		Shale	CM, CL
		530	55	60	475	470	5.2	20.0		Shale	CM, CH
Ing-Yot No.2 tunnel	DHB1SP	420	55	60	365	360	0.1	22.0	PTRgr	Granite porphyry	CM, CH, B
		420	60	65	360	355	2.1	22.0		Granite porphyry	CL, CH, CM
		420	65	70	355	350	2.4	22.0		Granite porphyry	CH, B, CM
		420	70	75	350	345	2.4	22.0		Granite porphyry	CM, B
		420	73	80	347	340	0.0	22.0		Granite porphyry	CM, CH
	DHB46SP	420	40	45	380	375	22.0	4.0	TRpl	Limestone	CM
		420	45	50	375	370	0.3	4.0		Limestone	CM
		420	50	55	370	365	13.0	4.0		Limestone	CH, CL
		420	57	60	363	360	7.5	4.0		Limestone	CH, CM
		420	60	65	360	355	1.5	4.0		Limestone	CM
		420	65	70	355	350	2.5	4.0		Limestone	CM, CL
		420	70	75	350	345	18.0	4.0		Limestone	CH, CM
		420	75	80	345	340	43.0	4.0		Limestone	CM
		420	80	85	340	335	13.0	4.0		Limestone	CM
		420	85	90	335	330	15.0	4.0		Limestone	CM, CL
		420	90	95	330	325	0.1	4.0		Limestone	CM
		420	91	96	329	324	1.4	4.0		Limestone	CM
	DHB50SP	420	70	75	350	345	1.2	15.5	TRhf	S.s. & Shale alt.	CM, CH, CL
		420	75	80	345	340	0.4	15.5		S.s. & Shale alt.	CM, CH, CL
		420	80	85	340	335	0.2	15.5		S.s. & Shale alt.	CM, CH, CL
		420	83	90	337	330	0.1	15.5		S.s. & Shale alt.	CM

* M.H.T.: Multi hydraulic tester

Figure11.2.2-6 Relationship between depth and Lugeon Value (Kok-Ing Tunnel etc.)

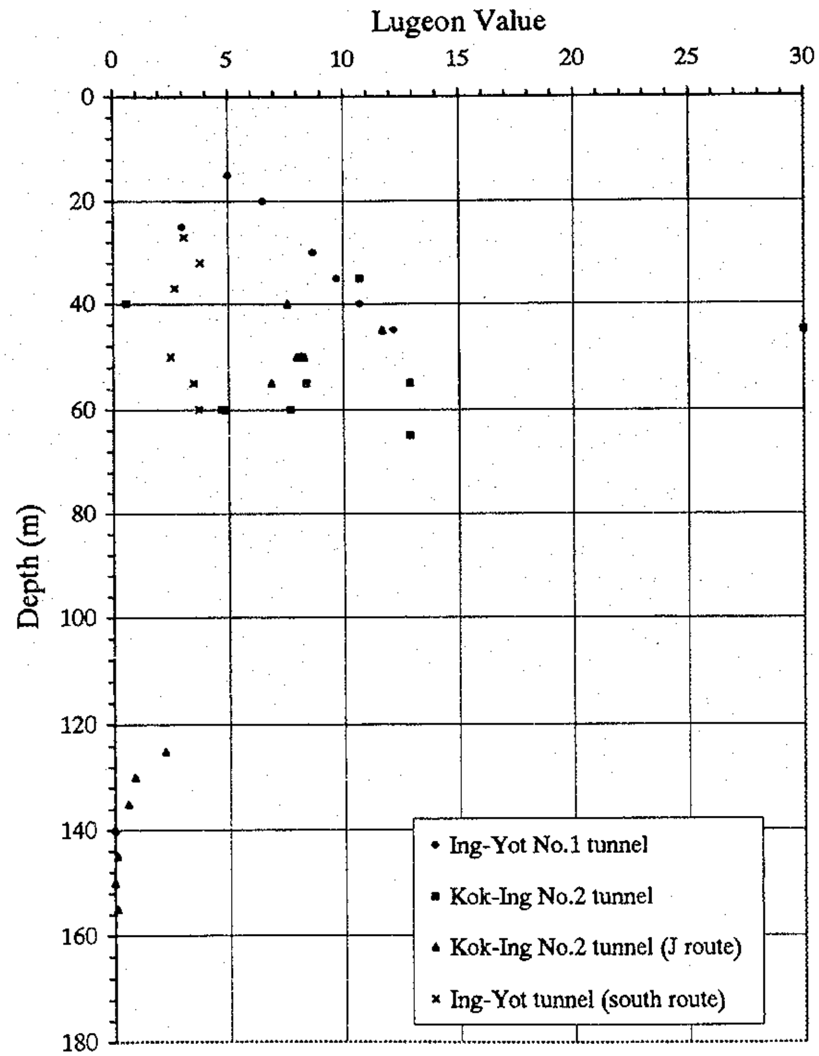


Figure11.2.2-7 Relationship between depth and Lugeon value (Ing-Yot No.2 Tunnel)

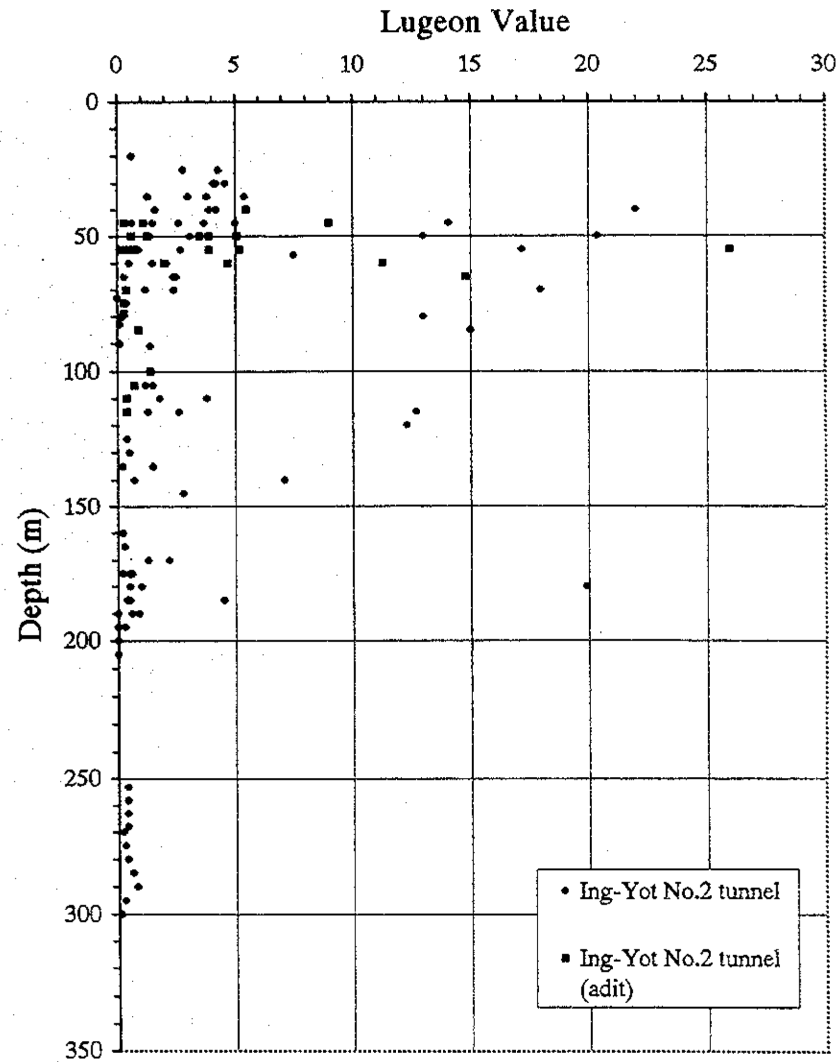


Figure11.2.2-8 Relationship between depth (EL.m) and Lugeon Value (Kok-Ing Tunnel etc.)

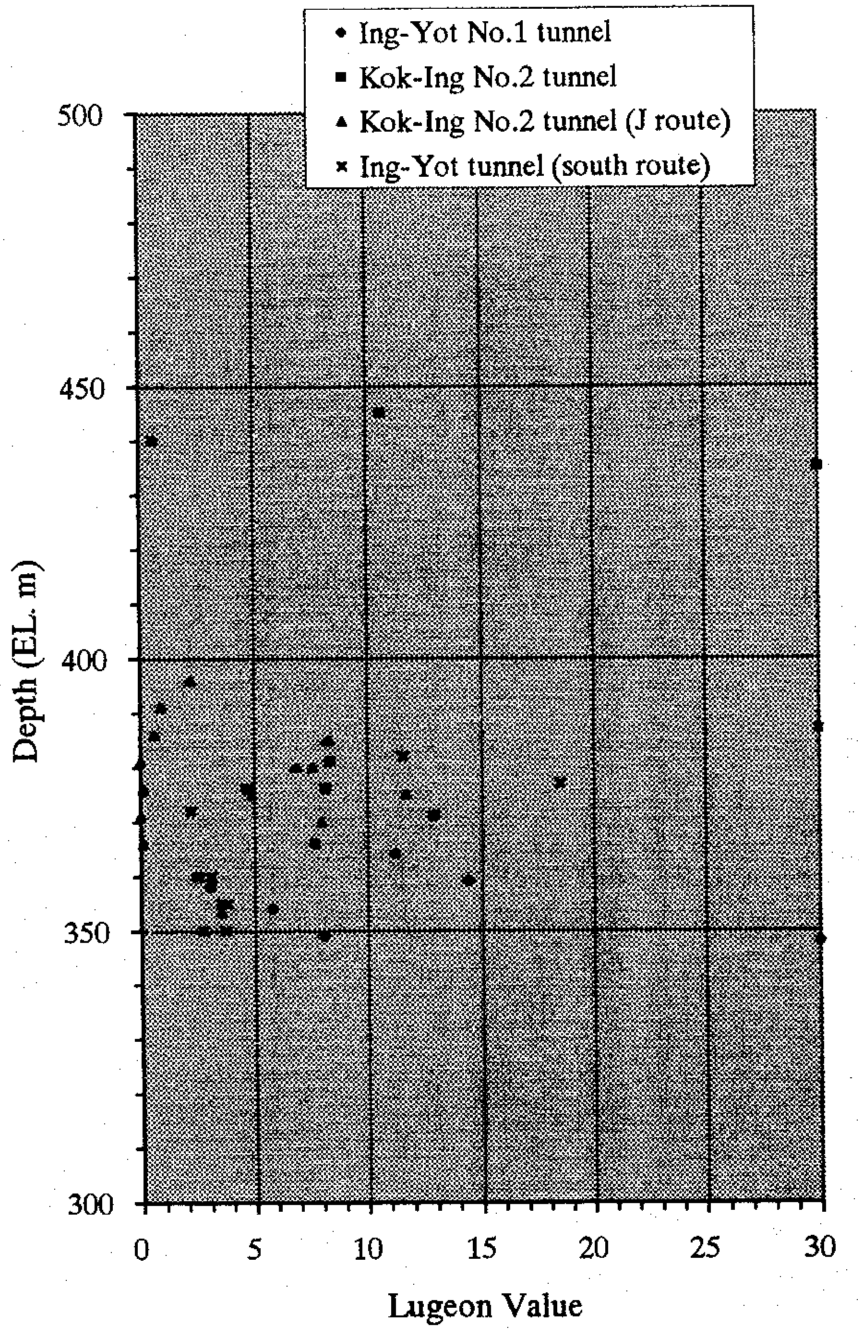


Figure11.2.2-9 Relationship between depth (EL.m) and Lugeon Value (Ing-Yot No.2 Tunnel)

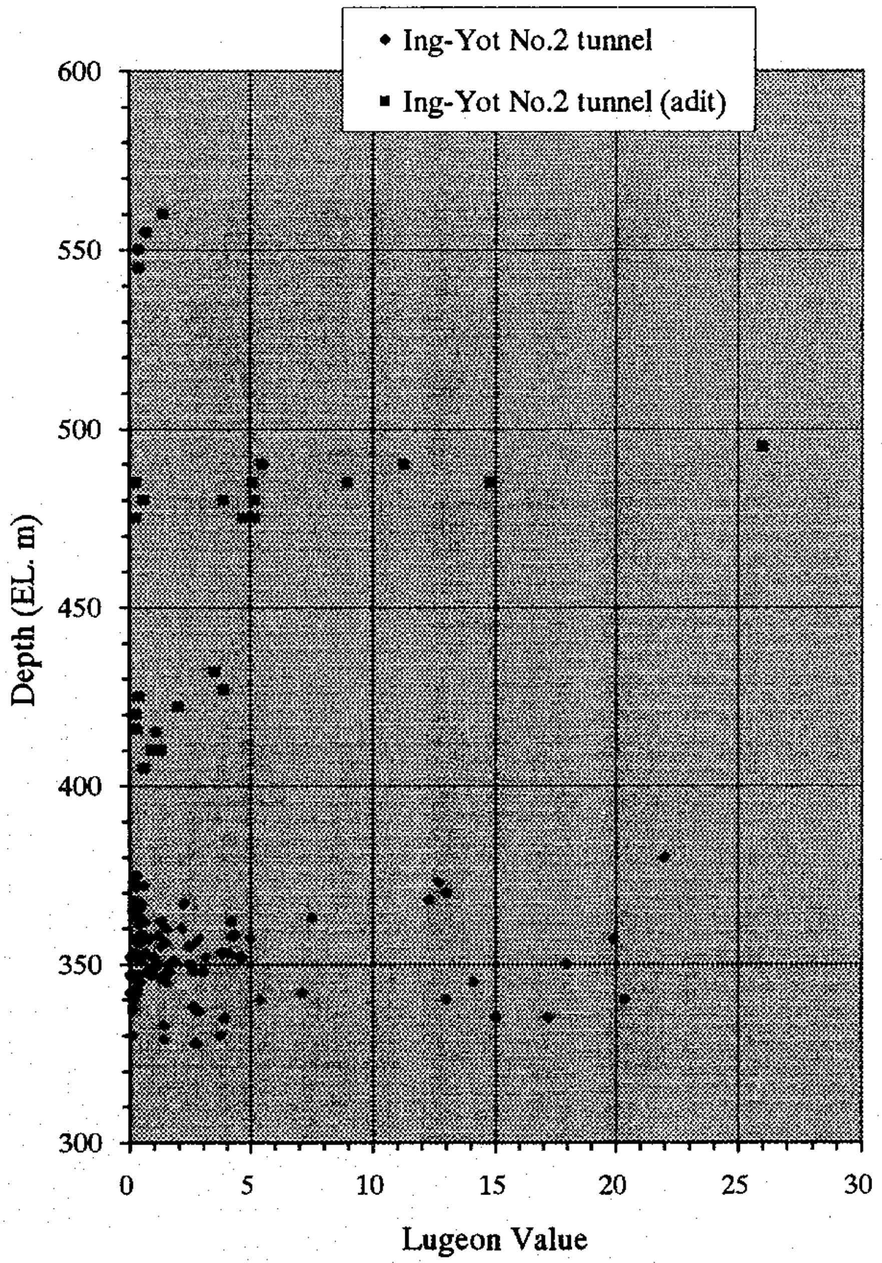


Table 11.2.2-17 Results of Geophysical Logging of Each Borehole (1)

Borehole No.	Kind of Logging	Depth	Range	Remarks
DHBJ-4.5	Electric logging			
(111-153 m)	Short normal	111-131 m	80-500	most of data show 80-300
	(ohm-m)	132-135 m	400-650	
		136-148 m	700-1,550	high resistivity (CM class of S.s., Sh., An)
		149-153 m	320-500	
	Long normal	111-132 m	100-200	
	(ohm-m)	133-150 m	380-800	high resistivity (CM class of S.s., Sh., An)
		151-153 m	280	
	SP logging (mv)		270-450	Sp curve shows monotonous line. values show (+)
	Gamma logging (cps)		15-80	in average, S.s. 47.1 Shale 47.1 Andesite 42.9
DHBJ-16.5	Electric logging			
(26-195 m)	Short normal	26-68 m	20-40	33, 38-40, 51-55 m show 50-163
	(ohm-m)	68-164 m	20-40	low resistivity, 73-83 m (>10), 92-101 m (8-13), 125-128 m (5-10), 140-160 m (3-12)
		165-186 m	15-40	
		187-195 m	5-10	low resistivity
	Long normal	26-31 m	>30	
	(ohm-m)	32-55 m	30-40	
		55-138 m	15-25	
		139-162 m	10-15	low resistivity
		162-190 m	15-20	
		191-195 m	10	low resistivity
	SP logging	26-138 m	(-)5-(-)200	values show (-), 32-132 m ((-)50-(-)200)
	(mv)	139-145 m	0-(-)25	values change from (-) to (+)
		146-173 m	0-75	values show (+)
		174-180 m	0-(-)70	values show (-)
		181-183 m	25-50	values show (+)
		184-187 m	0-(-)45	values show (-)
		188-195 m	5-175	values show (+)
	Gamma logging (cps)		40-82	in average, S.s.57.5 Slate 66.6

Borehole No.	Kind of Logging	Depth	Range	Remarks
DHBJ-18.0	Electric logging			
(82-203 m)	Short normal	82-90 m	10-(>)200	most of data show 20-30 or over
	(ohm-m)	91-96 m	8-12	low resistivity
		97-101 m	12-95	
		102-110 m	5-12	low resistivity
		111-113 m	120-(>)200	
		114-118 m	10-(>)200	
		119-126 m	5-12	low resistivity
		127-129 m	20-80	
		130-136 m	5-12	low resistivity
		137-142 m	10-160	
		143-149 m	>200	high resistivity (CM, CH class of S.s.)
		150-160 m	10-150	
		161-164 m	5-10	low resistivity
		165-168 m	25-60	
		169-172 m	10-12	low resistivity
		173-200 m	10-(>)200	
		201-203 m	5-8	low resistivity
	Long normal	82-100 m	13-42	
	(ohm-m)	101-111 m	5-12	low resistivity
		112-119 m	15-(>)200	
		120-126 m	10-15	low resistivity
		127-129 m	15-25	
		130-139 m	8-12	low resistivity
		140-143 m	15-70	
		144-148 m	>200	high resistivity (CM, CH class of S.s.)
		149-152 m	15-20	
		153-178 m	10-30	most of data show 10-15
		179-194 m	15-30	
		195-203 m	5-10	low resistivity
	SP logging	90-131 m	(-)10-(-)200	values show (-)
	(mv)	132-155 m	0-75	values show (+), part of data show (-) 10-(-)60
		156-158 m	0-(-)25	values change from (+) to (-)
		159-198 m	(-)50-(-)200	values show (-)
		199-203 m	5-60	values show (+)
	Gamma logging (cps)		25-83	in average, S.s.50.7 Slate 69.4

Table 11.2.2-18 Results of Geophysical Logging of Each Borehole (2)

Borehole No.	Kind of Logging	Depth	Range	Remarks
DHBJ-22.5	Electric logging			
(12-219 m)	Short normal	12-14 m	75-115	high resistivity
	(ohm-m)	15-194 m	20-80	
				87 m (151), 107-111 m (100-400), 144-146 m (120-1,000), 155 m (550), 161-166 m (120-(>)1,000, 169 m (125), 176 m (250), 190-191 m ((>)1,000), 161-166 m S.s. CH-B
		195-219 m	150-(>)1,000	high resistivity (S.s. CH)
	Long normal	12-13 m	90-150	
	(ohm-m)	14-194 m	20-90	high resistivity
				145 m (130), 162-166 m (100-450), 190 m (150)
		195-219 m	140-550	
	SP logging	12-188 m	(-)200-(-)80	values show (-)
	(mv)	189-191 m	35-180	values show (+)
		192-203 m	0-(-)175	values show (-)
		204-210 m	25-130	values show (+)
		211-219 m	(-)5-250	values show (+), (-)
	Gamma logging (cps)		15-90	in average, S.s.52.8 Slate 63.0
DHBJ-26.0	Electric logging			
(38-300 m)	Short normal	38-191 m	1,000-6,800	
	(ohm-m)	192-224 m	6.800-(>)10,000	
		225-263 m	>10,000	high resistivity, B, B-CH, CH of tuff
		264-266 m	5,600-9,800	
		267-298 m	1,000-5,000	
		299-300 m	5,500-6,000	
	Long normal	38-191 m	1,000-9,400	
	(ohm-m)	192 m	8,200	
		193-265 m	>10,000	high resistivity, B, B-CH, CH of tuff
		266-267 m	5,500-8,500	
		268-298 m	1,400-7,400	
		299-300 m	8,000	
	SP logging	101-183 m	(-)10-(-)200	values show (-)
	(mv)	184-192 m	0-(-)40	values change from (-) to (+)
		193-289 m	15-135	values show (+)
		290-297 m	0-20	values show (+)
		298-300 m	50-110	values show (+)
	Gamma logging (cps)		6-52	in average, Tuff 32.1

Borehole No.	Kind of Logging	Depth	Range	Remarks
DHBJ-33.0	Electric logging	174-175 m	500	
(174-300 m)	Short normal	176-213 m	900-(>)2,000	
	(ohm-m)	214-236 m	400-1,300	low resistivity, CL class of tuff
		237-247 m	900-2.000	
		248-249 m	200-700	low resistivity, CL class of tuff
		250-271 m	1,100-2,700	
		272-279 m	3,500-(>)5,000	high resistivity, CH class of tuff
		280-300 m	1,500-4,000	293-295 m (3,600-4,000)
	Long normal	174-175 m	200-700	
	(ohm-m)	176-212 m	800-(>)2,000	
		213-238 m	500-1,300	low resistivity, CL class of tuff
		239-247 m	1,000-1,600	
		248-251 m	400-900	low resistivity, CL class of tuff
		252-271 m	1,000-2,900	
		272-280 m	3,500-(>)5,000	high resistivity, CH class of tuff
		281-300 m	2,100-(>)5,000	293-296 m (3,900-(>)5,000)
	SP logging	174-203 m	(-)50-(-)150	values show (-)
	(mv)	204-257 m	(-)90-100	values show (+), (-)
		258-300 m	30-400	values show (+)
	Gamma logging (cps)		16-50	in average, S.s. 28.4 Tuff 31.1

Table 11.2.2-19 Summary of Vp Data by Full Waveform Sonic Logging

	DHBJ-4.5 (Vp km/sec)					
	S.s.		Shale		Andesite	
	CM	CL	CM	CL	CM	CL
Num.	5	2	2	21	10	3
Av.	5.42	4.45	5.55	4.68	5.39	4.07
Max.	5.8	4.5	5.7	5.6	6.1	4.8
Med.	5.4	4.5	5.6	4.7	5.3	3.8
Min.	5.1	4.4	5.4	3.4	5.0	3.6
Stdev.	0.29	0.07	0.21	0.67	0.41	0.64

* Formation : P3

	DHBJ-22.5 (Vp km/sec)					
	S.s.			Slate		
	B-CH	CH	CM	CH	CM	CL
Num.	7	33	2	72	67	4
Av.	4.86	4.81	4.45	4.60	4.31	3.98
Max.	5.0	5.3	4.5	5.4	4.9	4.5
Med.	4.8	4.9	4.5	4.6	4.3	4.0
Min.	4.7	4.1	4.4	4.0	3.4	3.4
Stdev.	0.11	0.28	0.07	0.29	0.33	0.51

* Formation : CPnb

	DHBJ-16.5 (Vp km/sec)			
	S.s.	Slate		
	CM	CH	CM	CL
Num.	5	79	67	19
Av.	4.56	4.48	4.39	4.02
Max.	4.7	5.1	5.5	4.6
Med.	4.6	4.5	4.4	4.0
Min.	4.3	3.7	3.0	3.5
Stdev.	0.15	0.30	0.40	0.29

* Formation : CPnb

	DHBJ-26.0 (Vp km/sec)			
	Tuff			
	B	B-CH	CH	CM
Num.	18	61	175	8
Av.	5.87	5.51	5.46	5.18
Max.	6.3	6.3	6.5	5.5
Med.	5.9	5.5	5.5	5.2
Min.	5.1	4.5	4.1	4.6
Stdev.	0.34	0.38	0.52	0.29

* Formation : PTRv

	DHBJ-18.0 (Vp km/sec)					
	S.s.			Slate		
	CH	CM	CL	CH	CM	CL
Num.	11	67	5	9	23	3
Av.	4.85	4.48	4.06	4.63	4.34	3.10
Max.	5.3	5.5	5.0	5.1	5.6	3.7
Med.	5.0	4.6	3.9	4.6	4.4	3.1
Min.	4.0	3.0	3.2	4.1	3.3	2.5
Stdev.	0.45	0.57	0.77	0.32	0.46	0.60

* Formation : CPnb

	DHBJ-33.0 (Vp km/sec)				
	Tuff			S.s.	
	CH	CM	CL	CM	CL
Num.	34	48	42	6	2
Av.	5.32	5.15	4.84	5.10	4.80
Max.	5.8	5.5	5.5	5.5	4.9
Med.	5.4	5.15	4.8	5.05	4.8
Min.	4.9	4.7	4.2	4.9	4.7
Stdev.	0.22	0.23	0.29	0.21	0.14

* Formation : TRhf

Remarks, Num.: Numbers, Av.: Average (km/sec), Max.: Maximum (km/sec), Med.: Median (km/sec)
Min.: Minimum (km/sec), Stdev.: Standard deviation

Table 11.2.2-20 Summary of Vs Data by Full Waveform Sonic Logging

	DHBJ-4.5 (Vs km/sec)					
	S.s.		Shale		Andesite	
	CM	CL	CM	CL	CM	CL
Num.	5	2	2	21	10	3
Av.	3.04	2.70	2.95	2.66	3.09	2.70
Max.	3.2	2.9	3.1	3.1	3.4	2.9
Med.	3.0	2.7	3.0	2.8	3.0	2.8
Min.	3.0	2.5	2.8	2.2	2.9	2.4
Stdev.	0.09	0.28	0.21	0.30	0.17	0.26

	DHBJ-22.5 (Vs km/sec)					
	S.s.			Slate		
	B-CH	CH	CM	CH	CM	CL
Num.	7	33	2	72	67	4
Av.	2.90	2.86	2.80	2.83	2.78	2.65
Max.	3.0	3.2	2.8	3.4	3.1	2.8
Med.	2.9	2.8	2.8	2.8	2.8	2.7
Min.	2.8	2.5	2.8	2.3	2.2	2.4
Stdev.	0.08	0.16	0.00	0.16	0.16	0.17

	DHBJ-16.5 (Vs km/sec)			
	S.s.	Slate		
	CM	CH	CM	CL
Num.	5	79	67	19
Av.	2.78	2.87	2.79	2.72
Max.	3.1	3.4	3.4	3.0
Med.	2.7	2.9	2.8	2.8
Min.	2.6	2.2	2.1	2.2
Stdev.	0.19	0.23	0.24	0.23

	DHBJ-26.0 (Vs km/sec)			
	Tuff			
	B	B-CH	CH	CM
Num.	18	61	175	8
Av.	3.34	3.25	3.30	3.36
Max.	3.6	3.8	4	3.9
Med.	3.4	3.2	3.3	3.4
Min.	3	2.8	2.7	2.9
Stdev.	0.18	0.22	0.22	0.29

	DHBJ-18.0 (Vs km/sec)					
	S.s.			Slate		
	CH	CM	CL	CH	CM	CL
Num.	11	65	5	9	23	3
Av.	2.80	2.80	2.82	2.51	2.66	2.40
Max.	3.0	3.5	3.2	2.8	3.1	2.7
Med.	2.9	2.8	2.8	2.5	2.7	2.6
Min.	2.5	1.9	2.3	2.2	2.1	1.9
Stdev.	0.19	0.27	0.33	0.19	0.28	0.44

	DHBJ-33.0 (Vs km/sec)				
	Tuff			S.s.	
	CH	CM	CL	CM	CL
Num.	34	48	42	6	2
Av.	3.05	3.06	3.06	3.00	2.95
Max.	3.5	3.9	3.8	3.2	3.0
Med.	3.1	3.1	3.0	3.0	3.0
Min.	2.6	2.6	2.5	2.8	2.9
Stdev.	0.20	0.25	0.32	0.14	0.07

Table 11.2.2-21 Summary of Resistivity (Short Normal) Data by Electric Logging

	DHBJ-4.5 (ohm-m)					
	S.s.		Shale		Andesite	
	CM	CL	CM	CL	CM	CL
Num	6	1	2	21	10	3
Av.	675.0	180.0	750.0	279.3	867.0	513.3
Max.	1,200	180	800	850	1,550	1,350
Med.	515	180	750	220	735	100
Min.	320	180	700	80	400	90
Stdev.	377.2	-	70.7	198.1	404.0	724.6

* Unit : ohm-m * Formation : P3

	DHBJ-22.5 (ohm-m)					
	S.s.			Slate		
	CH-B	CH	CM	CH	CM	CL
Num	7	33	2	73	67	21
Av.	574.3	475.5	50.0	36.0	55.7	39.6
Max.	>1,000	>1,000	75	1,000	1,000	115
Med.	675	420	50	50	30	30
Min.	65	20	25	15	10	20
Stdev.	445.6	335.8	35.4	143.2	124.5	25.1

* Formation : CPnb

	DHBJ-16.5 (ohm-m)			
	S.s.	Slate		
	CM	CH	CM	CL
Num	6	77	66	19
Av.	16.7	21.8	22.9	20.7
Max.	30	163	162	73
Med.	16	15	19	17
Min.	10	3	5	5
Stdev.	7.4	26.7	22.1	14.2

* Formation : CPnb

	DHBJ-26.0 (ohm-m)			
	Tuff			
	B	B-CH	CH	CM
Num	18	61	176	8
Av.	6,655.6	4,450.8	4,928.4	4,362.5
Max.	>10,000	>10,000	>10,000	>10,000
Med.	6,950	3,800	3,600	4,300
Min.	1,800	1,300	500	1,100
Stdev.	3,375.7	2,409.8	3,242.8	2,690.7

* Formation : PTRv

* On the occasion of computation as for Av. and Stdev., >10,000 value is converted as 10,000.

	DHBJ-18.0 (ohm-m)					
	S.s.			Slate		
	CH	CM	CL	CH	CM	CL
Num	11	70	5	9	23	3
Av.	81.4	45.6	42.6	17.8	30.0	40.0
Max.	>200	>200	160	30	>200	55
Med.	30	20	15	15	10	35
Min.	10	5	10	10	5	30
Stdev.	81.8	61.8	65.7	8.3	45.9	13.2

* Formation : CPnb

* On the occasion of computation as for Av. and Stdev., >200 value is converted as 200.

	DHBJ-33.0 (ohm-m)				
	Tuff			S.s.	
	CH	CM	CL	CH	CM
Num	34	47	44	6	2
Av.	2,835.3	1,741.5	1,208.4	1,466.7	1,075.0
Max.	>5,000	2,800	2,500	2,000	1,500
Med.	2,450	1,700	1,100	1,425	1,075
Min.	1,200	200	400	1,000	650
Stdev.	1,054.5	563.3	537.4	328.1	601.0

* Formation : TRhf

* On the occasion of computation as for Av. and Stdev., >5,000 value is converted as 5,000.

Remarks Num.: Numbers, Av.: Average (ohm-m), Min.: Minimum (ohm-m), Med.: Median (ohm-m)
Max.: Maximum (ohm-m), Stdev.: Standard deviation

Table 11.2.2-22 Summary of Resistivity (Long Normal) Data by Electric Logging

	DHBJ-4.5 (ohm-m)					
	S.s.		Shale		Andesite	
	CM	CL	CM	CL	CM	CL
Num	6	1	2	21	10	3
Av.	396.7	100.0	625.0	182.1	569.0	273.3
Max.	600	100	650	550	800	550
Med.	365	100	625	150	590	150
Min.	250	100	600	100	380	120
Stdev.	157.7	-	35.4	123.0	157.8	240.1

* Unit : ohm-m

	DHBJ-22.5 (ohm-m)					
	S.s.			Slate		
	CH-B	CH	CM	CH	CM	CL
Num	7	33	2	73	67	21
Av.	194.3	237.3	45.0	36.0	36.6	42.5
Max.	450	550	60	100	230	150
Med.	110	200	45	30	25	27
Min.	40	20	30	10	15	20
Stdev.	150.0	171.9	21.2	16.2	33.2	30.8

	DHBJ-16.5 (ohm-m)			
	S.s.	Slate		
	CM	CH	CM	CL
Num	6	77	66	19
Av.	16.2	19.8	18.9	20.2
Max.	23	39	40	30
Med.	15	17	18	20
Min.	12	10	10	10
Stdev.	4.4	8.4	6.6	4.8

	DHBJ-26.0 (ohm-m)			
	Tuff			
	B	B-CH	CH	CM
Num	18	61	176	8
Av.	7,283.3	4,873.8	5,304.0	5,112.5
Max.	>10,000	>10,000	>10,000	>10,000
Med.	10,000	4,100	4,000	5,000
Min.	1,800	900	500	1,300
Stdev.	3,432.8	2,617.4	3,561.1	2,784.4

* On the occasion of computation as for Av. and Stdev., >10,000 value is converted as 10,000.

	DHBJ-18.0 (ohm-m)					
	S.s.			Slate		
	CH	CM	CL	CH	CM	CL
Num	11	70	5	9	23	3
Av.	47.7	25.8	11.6	20.8	16.6	25.0
Max.	>200	>200	15	30	42	30
Med.	15	12	10	20	13	25
Min.	5	5	8	15	10	20
Stdev.	75.5	44.5	3.2	5.8	9.3	5.0

* On the occasion of computation as for Av. and Stdev., >200 value is converted as 200.

	DHBJ-33.0 (ohm-m)				
	S.s.		Tuff		
	CH	CM	CH	CM	CL
Num	6	2	34	47	44
Av.	1,271.7	875.0	3,241.2	1,711.3	1,026.1
Max.	1,500	900	>5,000	2,900	2,800
Med.	1,350	875	2,950	1,500	875
Min.	800	850	1400	400	500
Stdev.	257.7	35.4	1,217.3	697.5	581.9

* On the occasion of computation as for Av. and Stdev., >5,000 value is converted as 5,000.

Remarks Num.: Numbers, Av.: Average (ohm-m), Min.: Minimum (ohm-m), Med.: Median (ohm-m)
Max.: Maximum (ohm-m), Stdev.: Standard deviation