CHAPTER 1 ORE RESOURCES EVALUATION

1-1 Methodology of Ore Resources Evaluations

Ore resources evaluation was conducted by using Genesis Module of MINEX software produced by Engineering Computer Services International Pty. Ltd. Hardware utilized was SUN Microsystems running on UNIX.

The flow used for the ore resources evaluations is as follows:

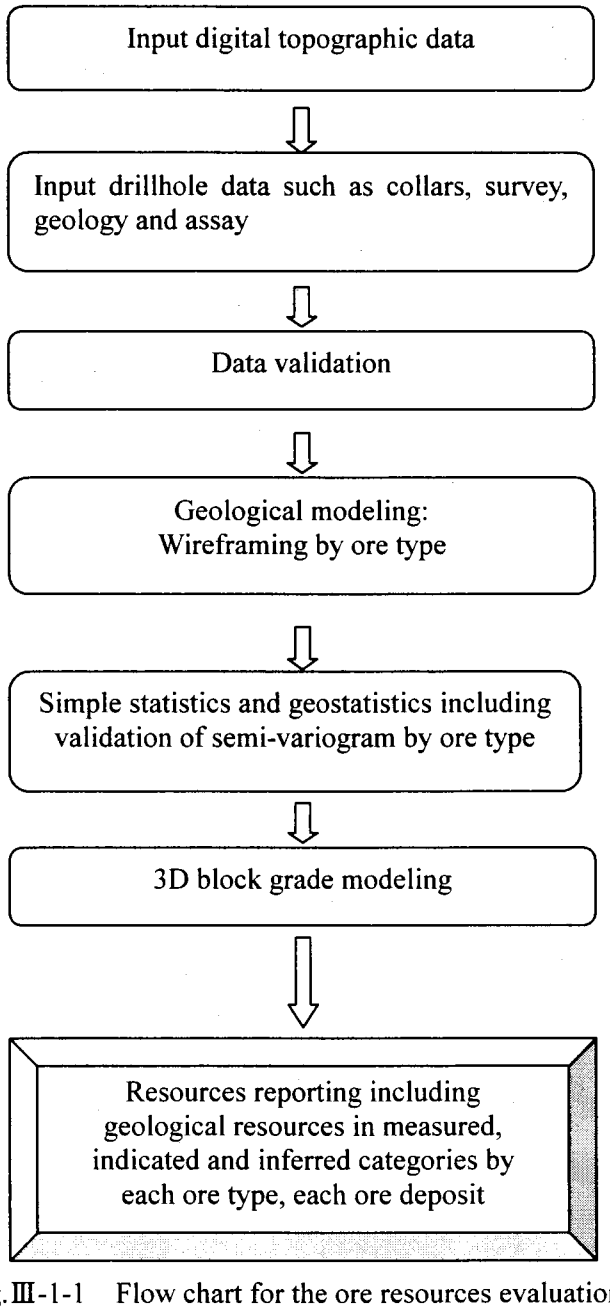

Fig.Ⅲ-1-1 Flow chart for the ore resources evaluation

1-2 Data Input

1-2-1 Digital topographic data and area creation for ore resources evaluation

In the project area, the Rakah ore body is assumed from 457,000E to 457,600E and from 2,618,500N to 2,619,000N. Hayl As Safil, Al Asghar, Al Bishara and Al Jadeed ore bodies are assumed from 452,500E to 454,000E and from 2,618,000N to 2,620,000N in the UTM coordinate system. The followings are the parameters used for the topographic data over the whole area including 5 deposits:

Table Ⅲ-1-1 Coordinate – project area

Parameter	Direction	
	East - west	North – south
Origin (m)	451,000	2,616,000
Extent (m)	8,000	5,000
Mesh (m)	20	20

Digital topographic data, available during the process of this project, was compiled in the middle of Year 2000 so that the pit shape of Rakah Gold Mine was also considered for ore resource calculations. Contour intervals are 10 meters at the mountains and 2 meters at the wadis.

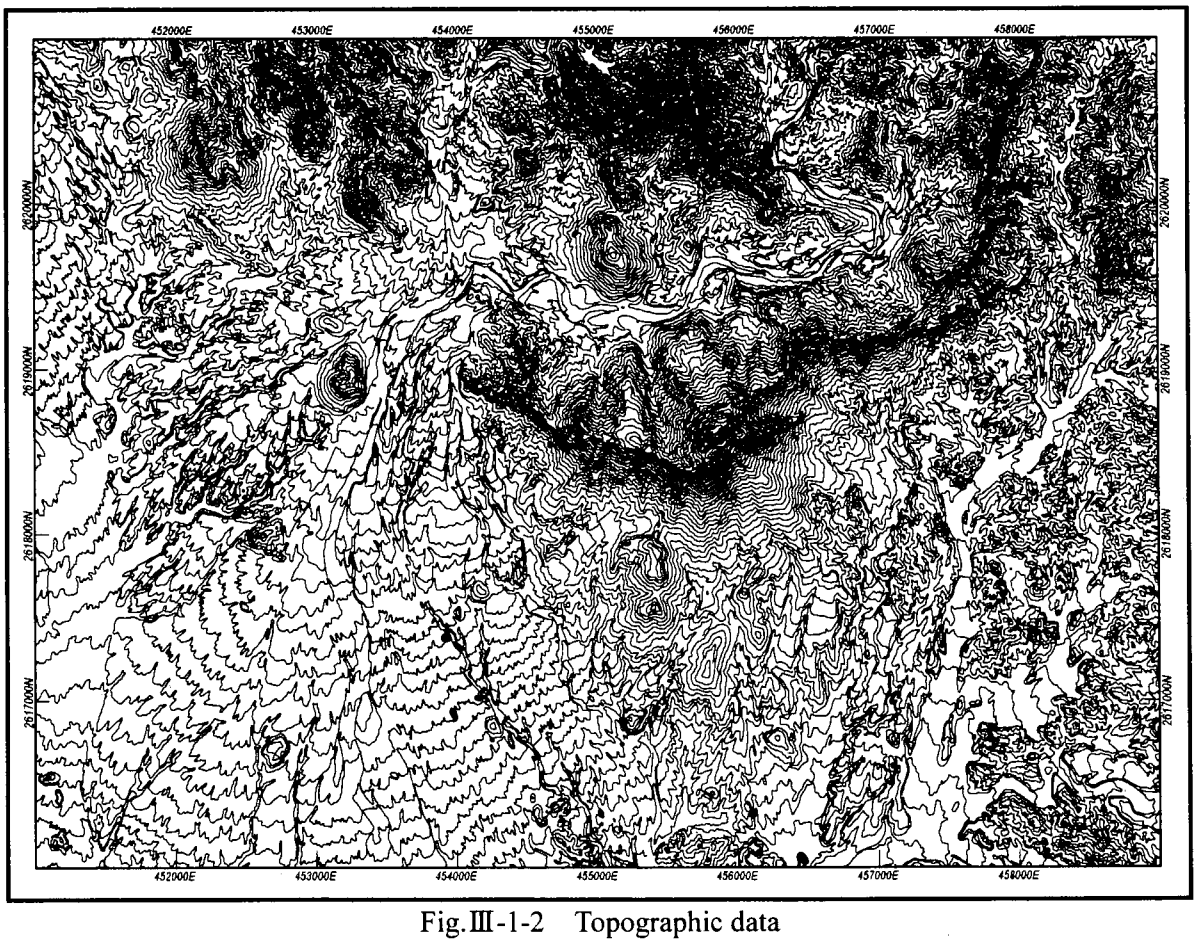

Fig.Ⅲ-1-2 Topographic data

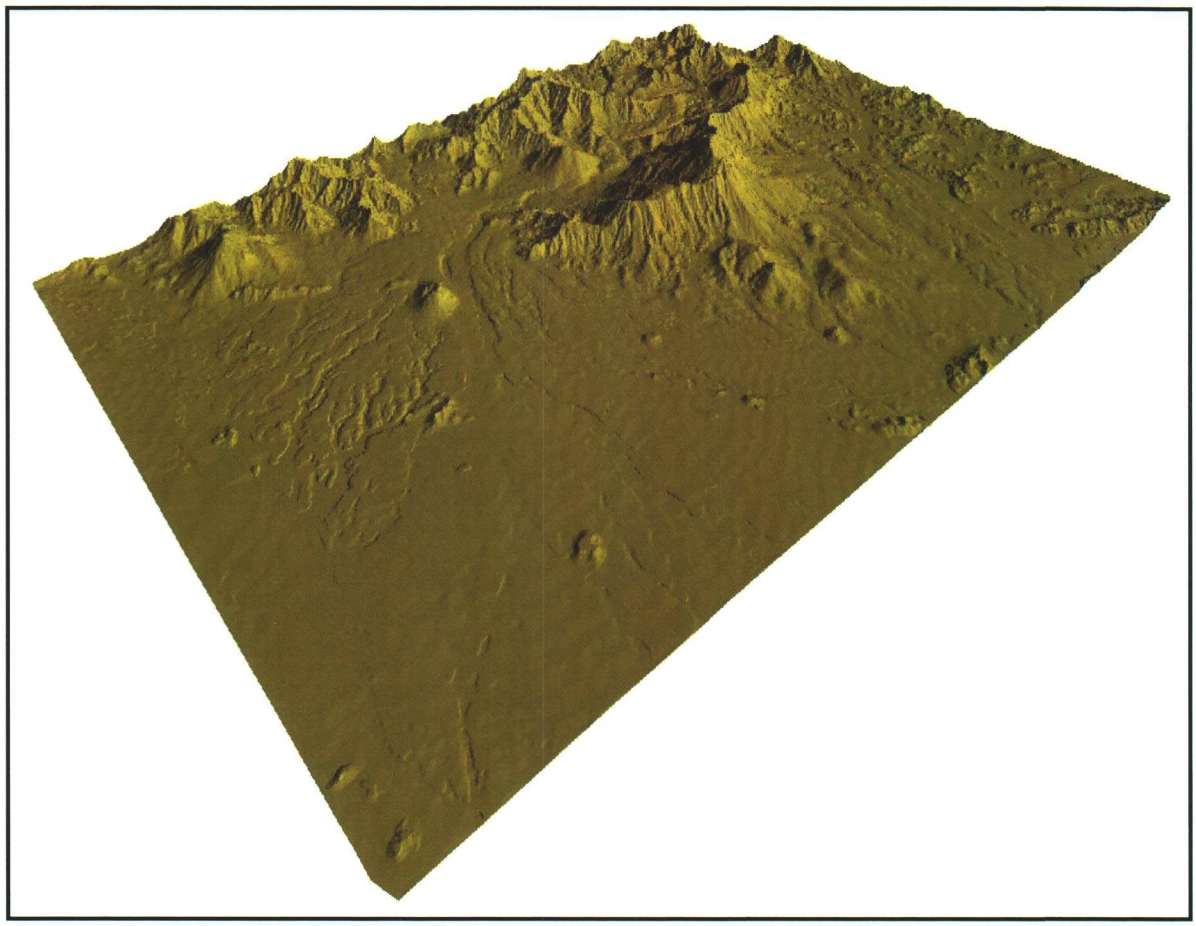

Fig.Ⅲ-1-3 Topographic surface in perspective view looking NE

1-2-2 Drillhole databasing

A drillhole database available in the project area on 1st of April, 2001 consists of 548 drillholes, totaling 52,006.1 meters. Detailed figures by ore body are indicated in Table Ⅲ-1-2:

Table Ⅲ-1-2 Summary of Drillhole

Ore body	Drillholes	Length(m)	Samples
Rakah	156	13,103.2	3,364
Hayl As Safil	97	13,946.7	2,307
Al Asghar	78	5,600.1	627
Al Bishara	147	14,079.9	1,836
Al Jadeed	70	5,276.2	367
Total	548	52,006.1	8,501

Locations of each ore deposit and drill-hole collars are indicated in Fig.Ⅲ-1-4 and drillhole locations for each ore deposit are shown in Fig.Ⅲ-1-5 – Fig.Ⅲ-1-9.

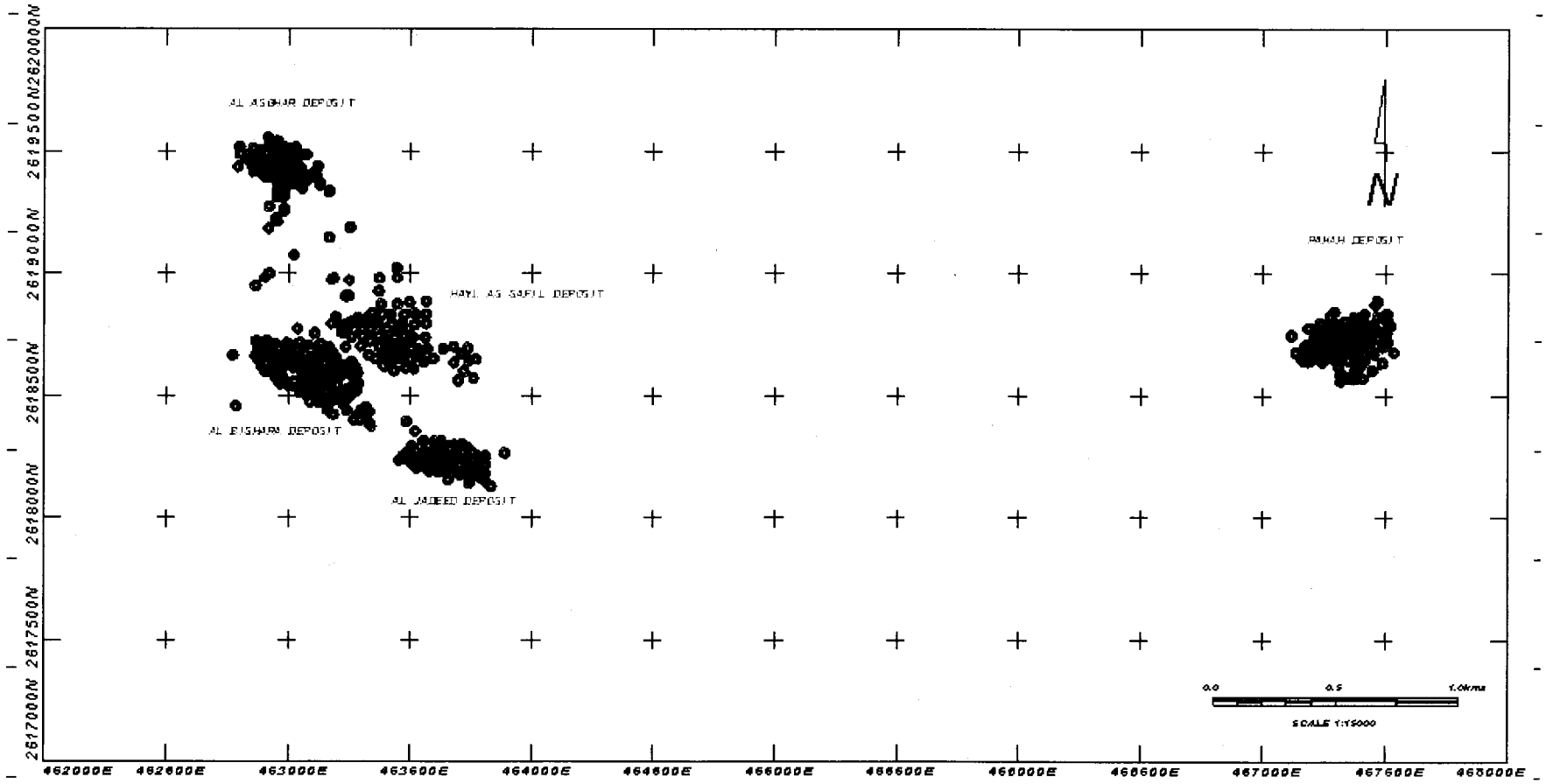

Fig.Ⅲ-1-4　Locations of each ore deposit and drill-hole collars

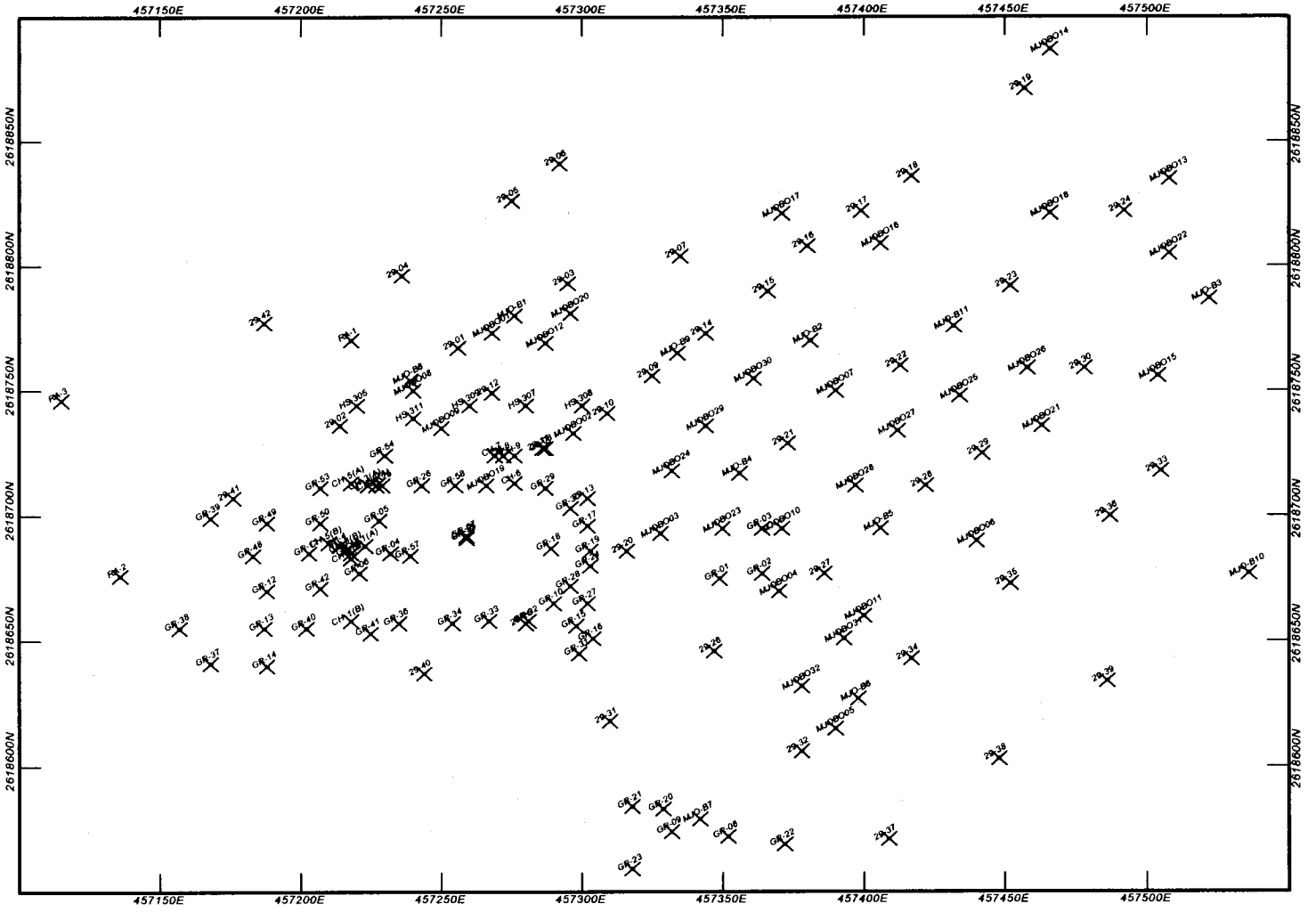

Fig.Ⅲ-1-5 Rakah – Drillhole collar locations

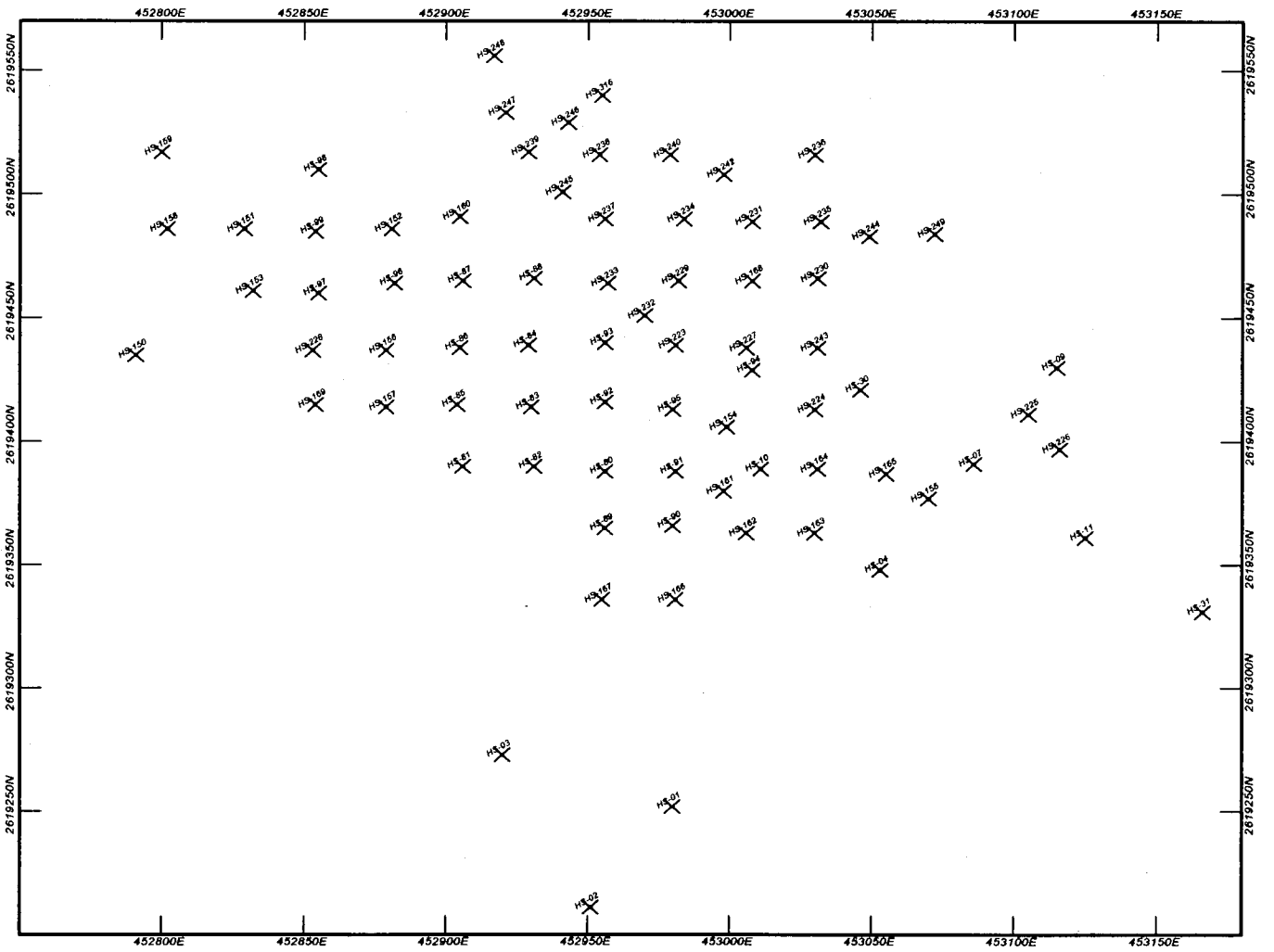

Fig.Ⅲ-1-6 Al Asghar – Drillhole collar locations

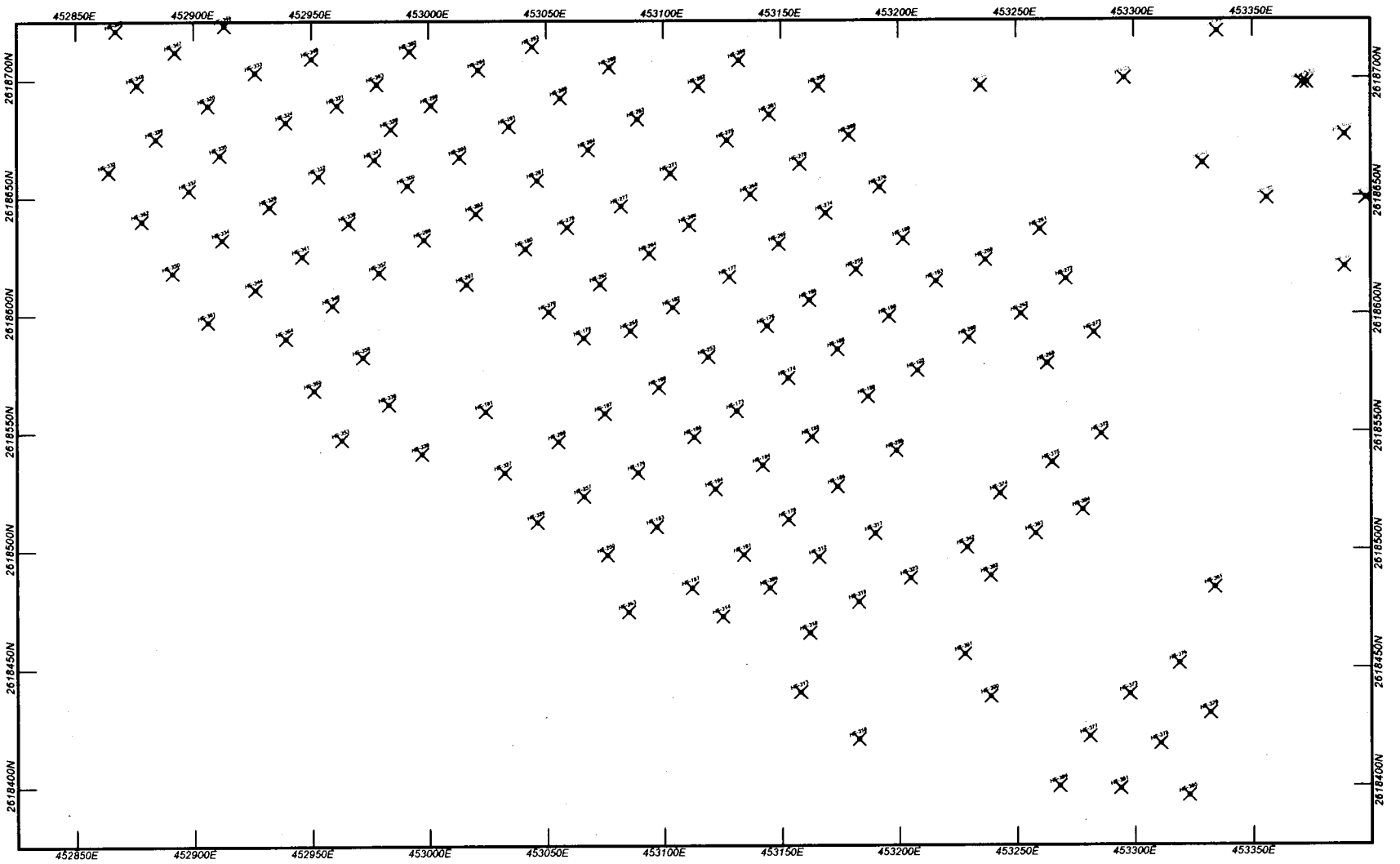

Fig.Ⅲ-1-7 Al Bishara – Drillhole collar locations

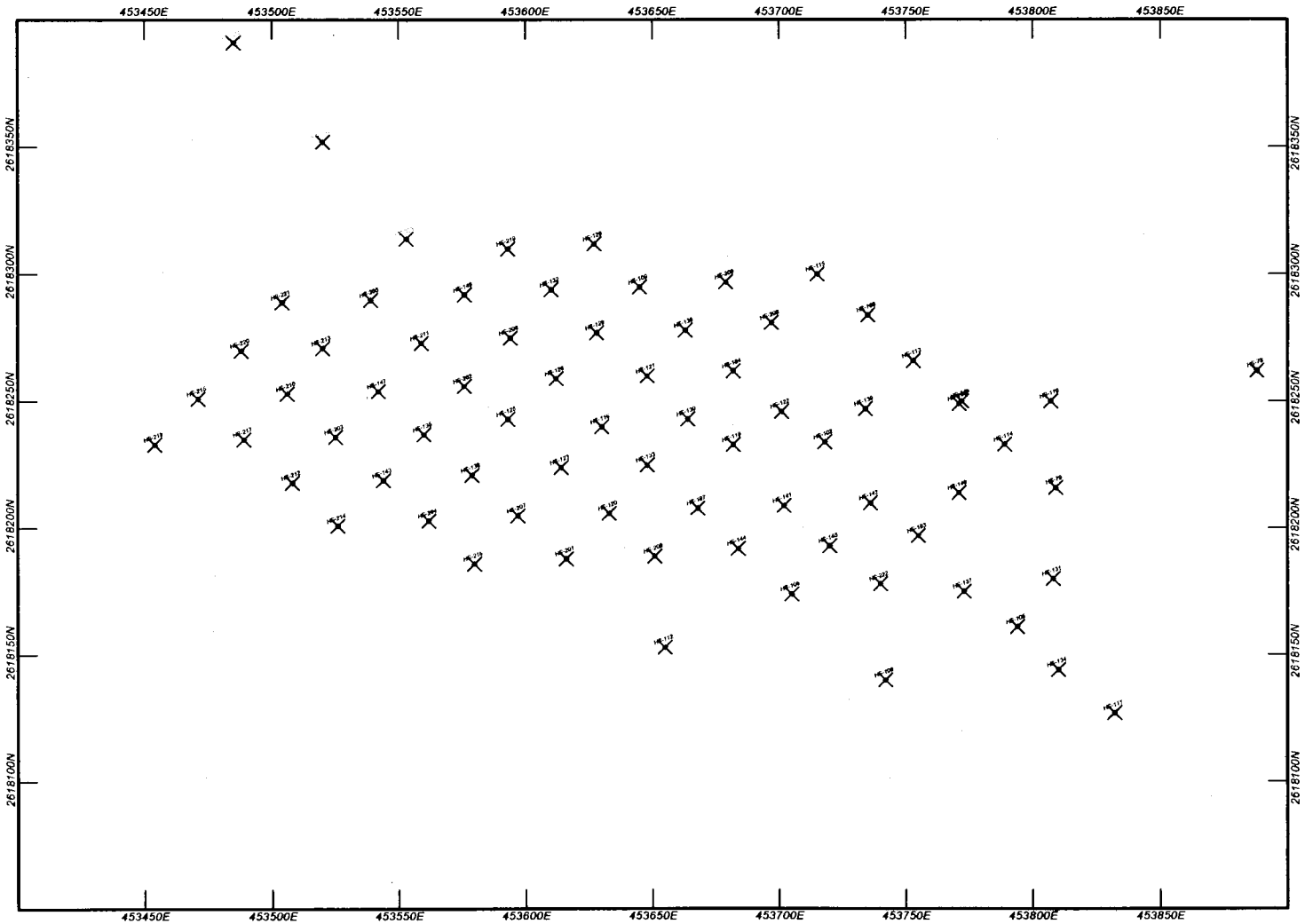

Fig.Ⅲ-1-8 Al Jadeed – Drillhole collar locations

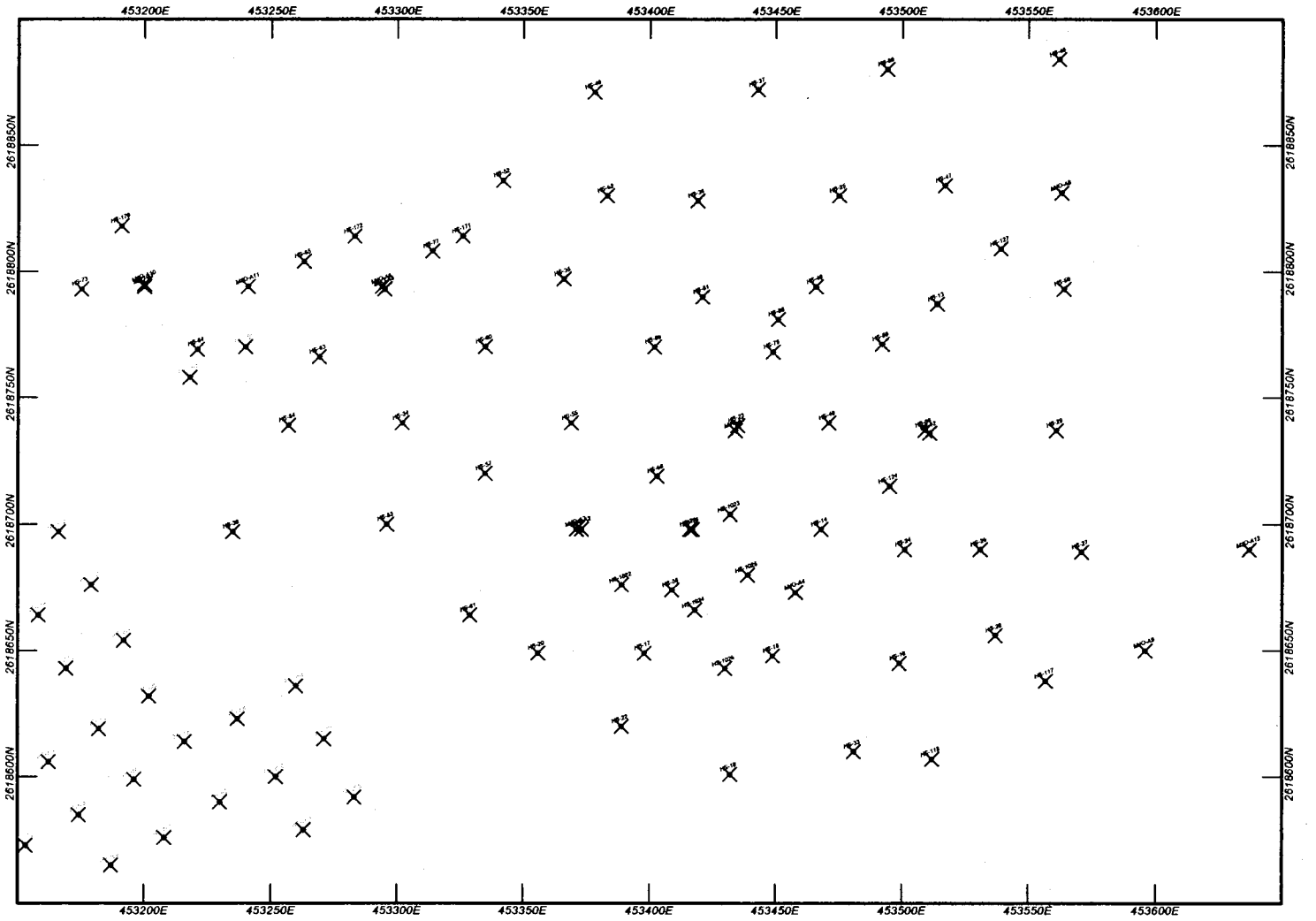

Fig.Ⅲ-1-9 Hayl As Safil – Drillhole collar locations

1-3 Geostatistics

1-3-1 Simple statistics of raw data

A first approach for ore resources evaluations was to validate the drillhole database samples by reporting simple statistics of copper and gold by ore body. In consideration of nugget effect, the whole revised data set with raw data over 95 percentile grade were validated by using top-cut to high cut limits. The high cut limits vary by ore bodies because of different distributions among them. Top-cutting has also been used for block grade interpolation and is thought to be effective for refraining from grade overestimation.

Table Ⅲ-1-3 Raw copper statistics

Ore deposit	Lowest (%)	Highest (%)	Average (%)	Median (%)	Standard deviation	Variance
Rakah	0.02	39.5	0.75	0.38	1.55	2.39
	0.02	3.0	0.66	0.38	0.81	0.65
Hayl As Safil	0.02	23.5	0.93	0.49	1.92	3.70
	0.02	4.5	0.81	0.49	1.16	1.34
Al Asghar	0.04	14.4	2.05	1.29	2.67	7.16
	0.04	7.0	1.89	1.29	2.06	4.25
Al Bishara	0.02	21.5	1.14	0.78	1.51	2.28
	0.02	3.0	1.01	0.78	0.84	0.70
Al Jadeed	0.02	4.52	1.53	1.58	0.84	0.71
	0.02	3.0	1.51	1.58	0.80	0.64

Upper column: raw data, Lower column: after top-cutting

Table Ⅲ-1-4 Raw gold statistics

Ore deposit	Lowest (g/t)	Highest (g/t)	Average (g/t)	Median (g/t)	Standard deviation	Variance
Rakah	0.03	346.0	3.33	0.42	13.6	185.4
	0.03	10.0	1.62	0.42	2.75	7.57
Hayl As Safil	0.02	8.83	0.56	0.49	0.87	0.76
	0.02	3.0	0.54	0.30	0.72	0.52
Al Asghar	0.03	60.16	1.54	1.01	3.07	9.42
	0.03	5.0	1.19	1.01	1.05	1.10
Al Bishara	0.05	685	2.95	0.93	30.4	922.6
	0.05	10.0	1.53	0.93	2.27	5.16
Al Jadeed	0.05	2.59	0.75	0.77	0.55	0.30
	0.05	2.0	0.75	0.77	0.53	0.28

Upper column: raw data, Lower column: after top-cutting

Please note that raw copper values after top-cutting for Rakah and Bishara show significant

decrease of standard deviation and variance indicating betterment of data dispersion. As same as copper, raw gold values after top-cutting for Rakah, Al Asghar and Bishara show the plummeting of those parameters. These phenomena seem to be typical nugget effects.

1-3-2 Variography

Geostatistical analysis started with down-hole variography in order to get ideas about the nugget value for copper and gold in each ore body. Top-cutting was used, mostly derived during the simple statistics. No down-hole compositing was used.

The nugget, sill and range are reported for the best fit models for copper and gold:

Table Ⅲ-1-5 Down-hole model variogram for raw copper

Ore body/domain	Max(%)	Lag(m)	Intervals	Type	Nugget	Sill	Range(m)
Rakah/2	3.0	1.0	12	Spherical	0.21	0.43	9.0
Hayl As Safil/2	4.5	2.0	10	Spherical	0.23	0.45	14.0
Hayl As Safil/3	6.0	1.0	12	Spherical	0.30	2.30	8.0
Asghar/3	7.0	1.0	12	Spherical	1.20	2.80	6.5
Bishara/4	3.0	1.0	15	Spherical	0.22	0.42	11.0
Jadeed/4	3.0	0.5	20	Spherical	0.20	0.45	6.0

Table Ⅲ-1-6 Down hole model variogram of raw gold

Ore body/domain	Max(%)	Lag(m)	Intervals	Type	Nugget	Sill	Range(m)
Rakah/2	10.0	1.0	12	Spherical	0.30	1.00	8.0
Hayl As Safil/2	3.0	2.0	10	Spherical	0.06	0.13	12.0
Hayl As Safil/3	3.0	1.5	12	Spherical	0.10	0.60	14.0
Asghar/3	5.0	1.0	12	Spherical	0.05	0.55	5.0
Bishara/4	10.0	1.0	15	Spherical	0.25	0.52	9.0
Jadeed/4	2.0	1.0	10	Spherical	0.03	0.20	7.0

Geostatistical analysis continued with 3D variography once the down-hole variography had given ideas of expected nugget values for elements in each ore body. 3D variography was performed to

determine maximum continuity distances (ranges) and their directions. Similar top-cutting to the down-hole variography were used. Each domain in each ore body was studied individually while Al Asghar domain2 was ignored due to insufficient number of samples.

Results of the variography are presented in the Table Ⅲ-1-17 at paragraph 1.4.1.

1-4 3D modeling

The following tables indicate the parameters of objected area by ore body for 3D modeling:

Table Ⅲ-1-7 Coordinate - Rakah

Parameter	Direction		
	East - west(X)	North - south(Y)	Altitude(Z)
Origin(m)	457,190	2,618,500	403
Extent(m)	320	400	390
Max(m)	457,510	2,618,900	793

Table Ⅲ-1-8 Coordinate – Hayl As Safil

Parameter	Direction		
	East - west(X)	North - south(Y)	Altitude(Z)
Origin(m)	453,100	2,618,650	422
Extent(m)	500	200	391
Max(m)	453,600	2,618,850	813

Table Ⅲ-1-9 Coordinate – Al Asghar

Parameter	Direction		
	East - west(X)	North - south(Y)	Altitude(Z)
Origin(m)	452,825	2,619,300	500
Extent(m)	250	300	200
Max(m)	453,075	2,619,600	700

Table Ⅲ-1-10 Coordinate - Bishara

Parameter	Direction		
	East - west(X)	North - south(Y)	Altitude(Z)
Origin(m)	452,825	2,618,400	500
Extent(m)	565	275	200
Max(m)	453,390	2,618,675	700

Table Ⅲ-1-11 Coordinate - Al Jadeed

Parameter	Direction		
	East - west(X)	North - south(Y)	Altitude(Z)
Origin(m)	453,400	2,618,180	500
Extent(m)	500	120	200
Max(m)	453,900	2,618,300	700

Block sizes and sub-block sizes for ore bodies were set to be not less than approximately a quarter of drillhole spacing as in the Table Ⅲ-1-12. The block heights were set at the benches (or multiples) projected at mining phase.

Table Ⅲ-1-12 Block model parameters

Ore body	Direction		
	East - west (X)	North - south(Y)	Vertical(Z)
Rakah	5	5	6
	2.5	2.5	3
Hayl As Safil	10	10	10
	2.5	2.5	2.5
Al Asghar	10	10	10
	2.5	2.5	2.5
Al Bishara	10	10	10
	2.5	2.5	2.5
Al Jadeed	10	10	10
	2.5	2.5	2.5

1-4-1 Domain creation

Prior to 3D modeling, domains for clarifying features of geology, ore body and geological structures were determined. Table Ⅲ-1-13 summarises the domain numbers assigned to each geological, ore zone or feature:

Please note that domains 2, 3 and 4 only are classified into ore zones. The ore zone outlines were digitized as closed outline strings, and the faults as open outline strings. Each ore zone outlines is treated as hard boundary. Oxides in Bishara are included in domain 0, i.e. waste, because these would be treated as waste in this project while these are included in the drillhole database.

Table Ⅲ-1-13 Summary of geologic block models and codes(domains)

Domain	Zone	Area
0	Waste	All deposits
2	Stockwork ore	Rakah, Hayl As Safil and Al Asghar
3	Massive ore	Rakah, Hayl As Safil and Al Asghar
4	Brecciated ore	Bishara and Al Jadeed
5	Fault – sub-vertical	Rakah
6	Fault – low angle	Rakah
7	Fault – sub-vertical	Al Asghar
8	Fault – low angle	Al Asghar
9	Fault – sub-vertical	Al Jadeed
10	Fault – sub-vertical	Al Jadeed
11	Fault – sub-vertical	Bishara
12	Fault – sub-vertical	Bishara
13	Fault – sub-vertical	Rakah

The following tables show the results of simple statistics by ore zone domain in each ore body:

Table Ⅲ-1-14 Raw copper statistics within domains

	Lowest (%)	Highest (%)	Average (%)	Median (%)	Standard deviation	Variance
Rakah						
All domains(2 &3)	0.02	3.00	0.61	0.37	0.64	0.41
2	0.02	3.00	0.75	0.54	0.67	0.45
3	0.04	3.00	1.10	0.92	0.99	0.97
Hayl As Safil						
All domains(2&3)	0.02	4.50	0.76	0.47	0.86	0.74
2	0.02	4.50	0.94	0.64	0.88	0.78
3	0.17	4.38	1.43	1.10	1.07	1.15
Al Asghar						
All domains(2&3)	0.04	7.0	1.63	1.15	1.59	2.53
2	0.04	0.83	0.33	0.18	0.28	0.08
3	0.04	7.0	2.30	1.91	1.68	2.82
Bishara						
4	0.04	3.0	1.10	1.00	0.67	0.45
Al Jadeed						
4	0.02	3.0	1.58	1.60	0.72	0.52

Table Ⅲ-1-15 Raw gold statistics within domains

	Lowest (g/t)	Highest (g/t)	Average (g/t)	Median (g/t)	Standard deviation	Variance
Rakah						
All domains(2&3)	0.03	10.00	1.01	0.34	1.69	2.85
2	0.03	10.00	0.88	0.37	1.47	2.16
3	0.29	5.29	1.81	1.69	1.31	1.72
Hayl As Safil						
All domains(2&3)	0.02	3.00	0.52	0.30	0.61	0.37
2	0.02	2.94	0.43	0.25	0.51	0.26
3	0.09	3.00	1.20	1.00	0.84	0.70
Al Asghar						
All domains(2&3)	0.03	5.0	1.17	0.95	0.88	0.77
2	0.12	0.68	0.49	0.40	0.26	0.07
3	0.03	5.0	1.18	0.94	0.90	0.82
Bishara						
4	0.05	9.5	1.04	0.91	0.79	0.62
Al Jadeed						
4	0.05	2.0	0.80	0.78	0.52	0.27

1-4-2 Wire-framing

To complete the wire-frame modeling, all outlines were connected with wire-frames. For a better understanding of geology, ore body and geological structures, the following sections were produced:

Table Ⅲ-1-16 Summary of sections produced

Rakah	Hayl As Safil	Al Asghar	Bishara	Al Jadeed
20m spaced	50m spaced	25m spaced	25m spaced	20m spaced
457,190E	2,618,650N	452,825E	2,618,400N	2,618,180N
457,210E	2,618,700N	452,850E	2,618,425N	2,618,200N
457,230E	2,618,750N	452,875E	2,618,450N	2,618,220N
457,250E	2,618,800N	452,900E	2,618,475N	2,618,240N
457,270E	2618,850N	452,925E	2,618,500N	2,618,260N
457,290E		452,950E	2,618,525N	2,618,280N
457,310E		453,000E	2,618,550N	2,618,300N
457,330E		453,025E	2,618,575N	
457,350E		453,050E	2,618,600N	
457,370E		453,075E	2,618,625N	
457,390E			2,618,650N	
457,410E			2,618,675N	
457,430E				
457,450E				
457,470E				
457,490E				
457,510E				

The following figures illustrate the solid wire-frames 3D:

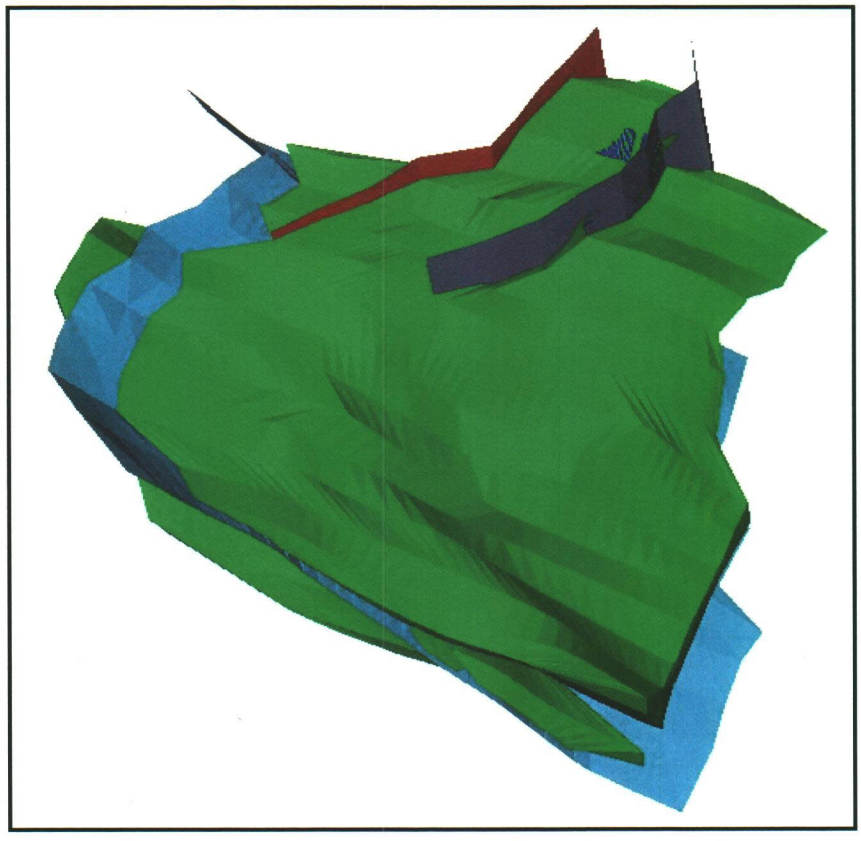

Fig.Ⅲ-1-10 Rakah – Wire-frames looking down towards west

LEGEND

Green : Stockwork Ore

Blue : Massive Ore

Pale Blue : Brecciated Ore

Other coulours : Faults

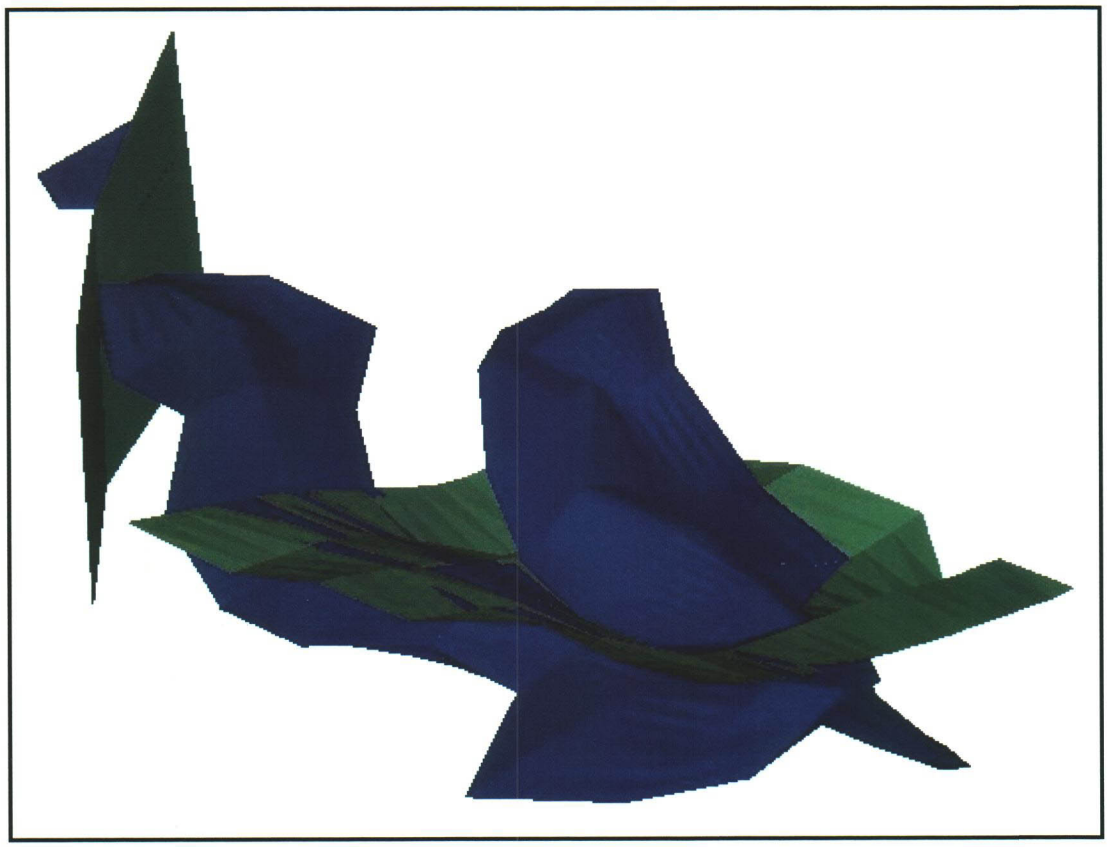

Fig.Ⅲ-1-11　Al Asghar - Wire-frames looking down towards north west

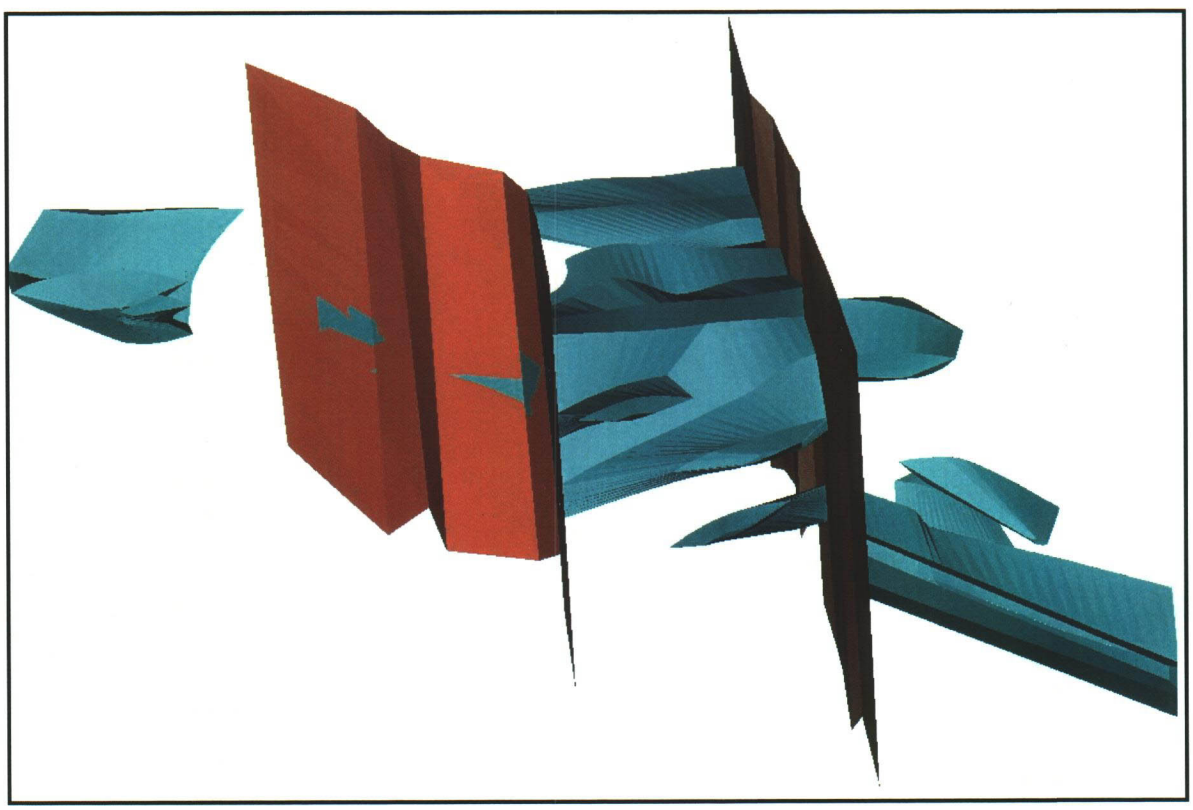

Fig.Ⅲ-1-12　Bishara - Wire-frames looking down towards north

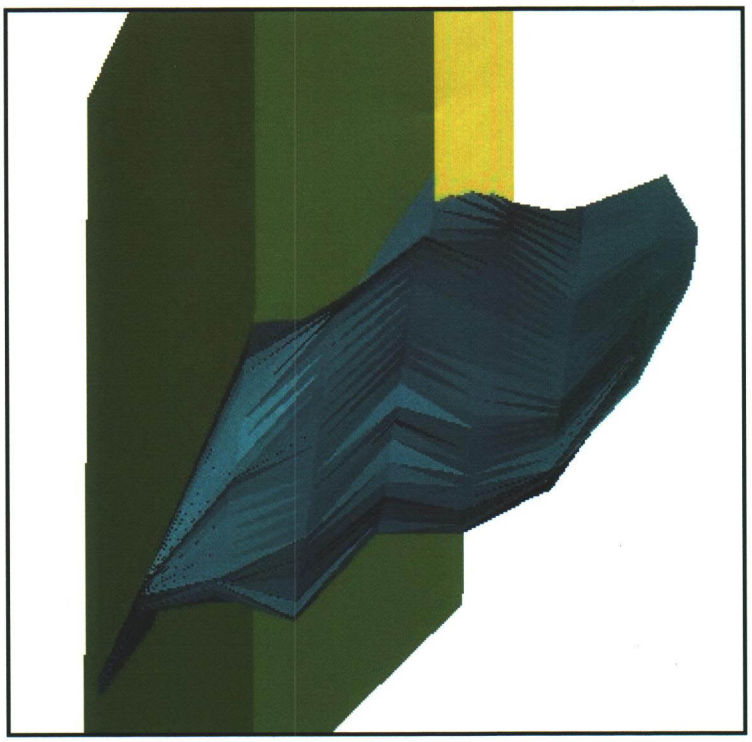

Fig.Ⅲ-1-13　Al Jadeed - Wire-frames looking down towards west

Fig.Ⅲ-1-14　Hayl As Safil - Wire-frames looking slightly down towards north