Analysis and Three Dimesional Modeling of Magnetometery Anomalies of Ghalanadar Ahar Cu-Fe Deposit

Saeed Kazem Alilou, Gholam-Hossain Norouzi, Faramarz Doulati, and Maysam Abedi

***Abstract*—**Three dimensional modeling of magnetometery data is an important topic, which nowadays is implemented by various methods and softwares. In this paper, three dimensional modeling of Ghalandar Cu-Fe deposit has been prepared. At first, total magnetic intensity map has been plotted after applying magnetic data corrections and then with the application of appropriate filters consisting of the reduced to magnetic pole and the first vertical derivative ones, effect of trivial shallow causative sources have been suppressed in order to remove noise intensity in inverse modeling. Subsequently, the upward continuation filter is used in different unit of depths (or different continuation level). For these data, variography have been applied and at last 3D block modeling is prepared by ordinary kriging method.

***Keywords*—**3D modeling, Magnetometery, Upward Continuation, Geostatistics, Ordinary Kriging, Cu-Fe Deposit, Ghalandar.

I. Introduction

THREE dimensional modeling of magnetometery data is one of the most important challenges in geophysical analysis. The most important factor in this challenge is the accuracy of modeling which could be different in each method [1]. Various people tried geometrical modeling of geophysical data. In these modeling which usually have been based on inversion, the most important effort was to distinguish the geometry of deposit [2], [3]. In this paper, it was tried to apply a simple method to modeling of magnetometery data. In this case, after the field surveys and applying of essential corrections, reduced to pole, first vertical derivative convolution executed on data and then upward continuation filter in different depths implemented. These filters converted to spatial data and then after geo-statistical operations, layers of different depths combined eachother and then 3 Dimensional block model of ore deposit have been created with ordinary kriging method.

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II. Geographical Location and the Geology of the Area

The exact location of Ghlanadar Area is in 23rd km, north of Ahar and 124th km of Tabriz, NW of Iran [4].

Study area contains lithology units of Eocene and Oligocene (65 to 24 million years ago) which have been created according to the influence of massive volcanic (Shivardagh batholith) in carbonated rocks which forms Fe-Cu skarns [5].

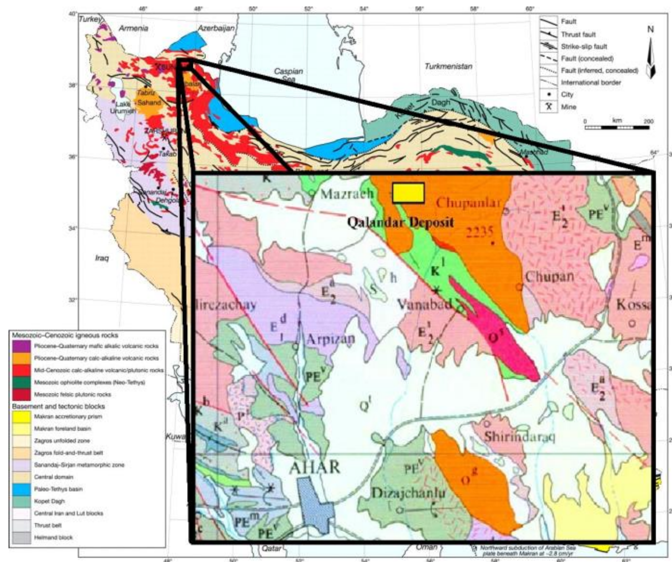

Fig. 1 location of study area in Ahar geological map

III. Magnetometery Data

After primary analysis of magnetometery data, total magnetic intensity map is shown in Fig. 2. Total magnetic intensity map has the maximum and minimum of 51000 and 46500 nT respectively. According to base magnetic intensity of this area which is 47809, residual maximum and minimum magnetic intensity is 2400 and -2100. In magnetic intensity map, total trend of mineralization is detected, which shows a northeast - southwest direction.

The reduced-to-pole (RTP) magnetic filter is used to remove the inclination effect of magnetic field in Fig. 3. At RTP map, anomalies approximately locate over the causative sources [3], [4]. The magnetic field has declination and inclination of 57.433 and 5.383 degree, respectively, with a constant background value of 47809 nT [4].

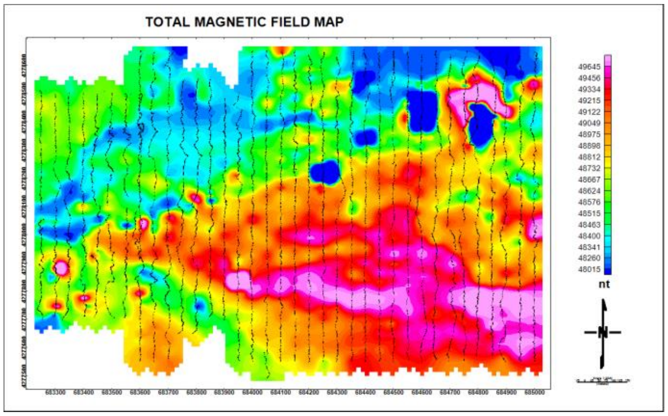

Fig. 2 Total magnetic intensity map

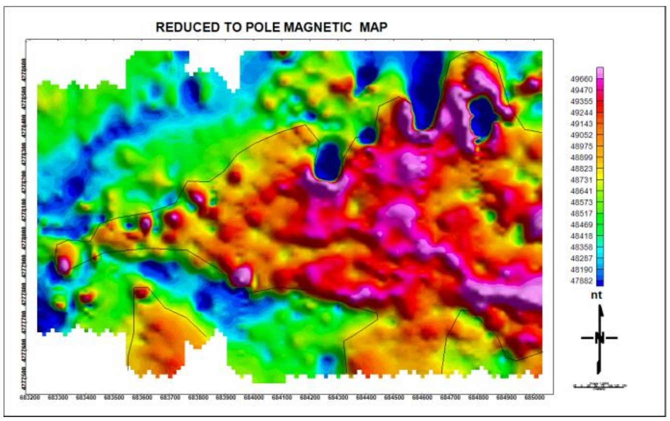

Fig. 3 Reduced to pole magnetic map

In first vertical derivative map, magnetic effects of superficial masses have been dominant and zonal effect and interference between anomalies is removed. First vertical convolution is a high pass filter. Fig. 4. shows a first vertical derivative map and comparing to reduced to pole magnetic map, some differences are specified. In this map, visible anomalies mostly are surficial with short duration. Also, according to removing of deep anomalies, surficial anomalies are more distinguished. As seen in this map, anomalies are not continues.

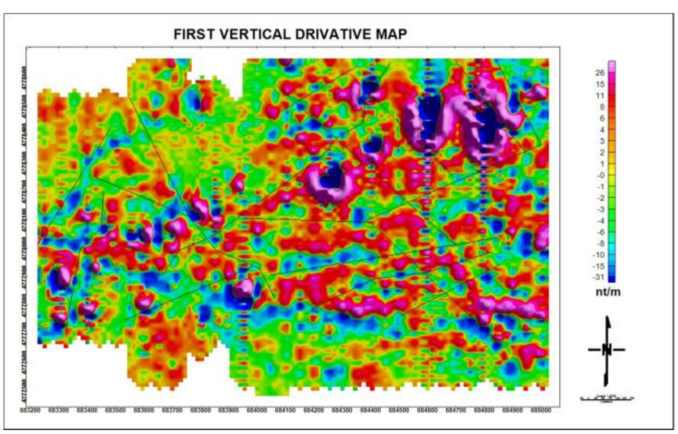

Fig. 4 First vertical derivative magnetic map

Existence of negative anomalies between positive anomalies in this map probably shows the oxidant zones and conversion of magnetite to hematite. This shows the adaptation with outcrops of study area [6].

Upward continuation method is a process in which magnetic data are imaged from a base surface to a upper surface by a mathematical method. Upward continuation filter applied to distinguish deep anomalies and is a low pass filter.

Upward continuation maps of this area in 5, 10, 15, 20, 30, 40, 60, 80 and 100 meters unit are shown in Fig. 5 and Fig. 6. As seen in these maps, anomalies seem to be deep [6].

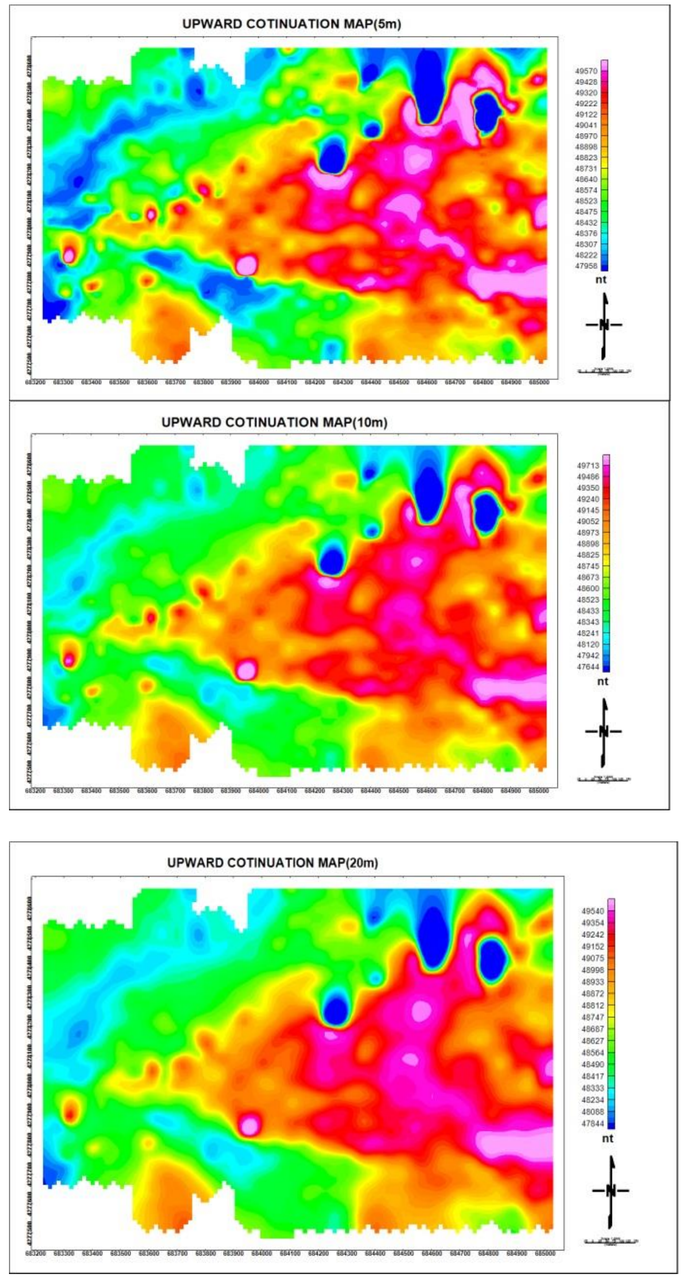

Fig. 5 Upward continuation maps at depths of 5, 10 and 20 meters

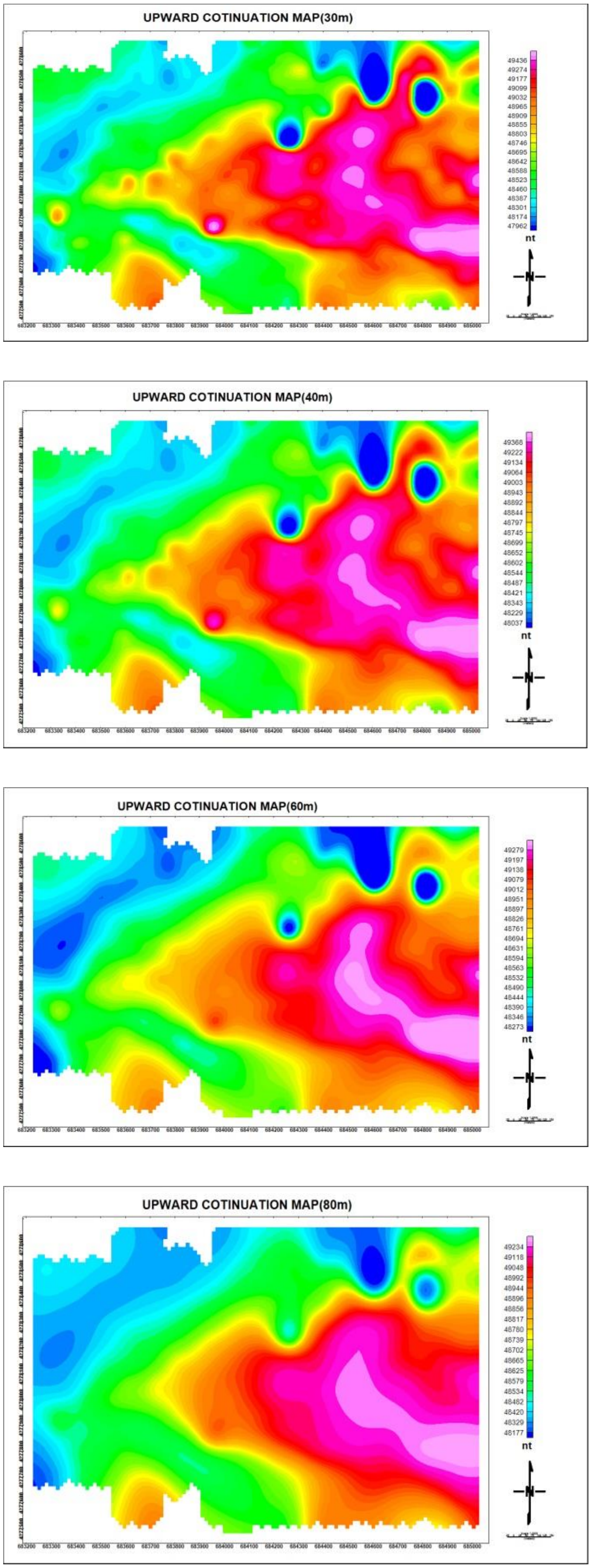

Fig. 6 Upward continuation maps at depths of 30, 40, 60 and 80 meters

IV. Geo-Statistical Analysis and Variography of Data

After applying filters and drawing maps, upward continuation maps created in different depths. These maps then converted to spatial data which every point has its own coordinates in space with magnetic intensity.

The most important geo-statistical analysis is to determine the distribution function of data. Therefore, histogram and cumulative function of data were drawn, and statistical parameters were calculated. Data mostly show lognormal distribution and show negative skewness. According to three dimensional modeling and estimating of ore deposit by ordinary kriging equations, distribution changed to normal and then statistical parameters were calculated again. In Fig. 7 and Fig. 8 histogram of data are shown before and after the normalization.

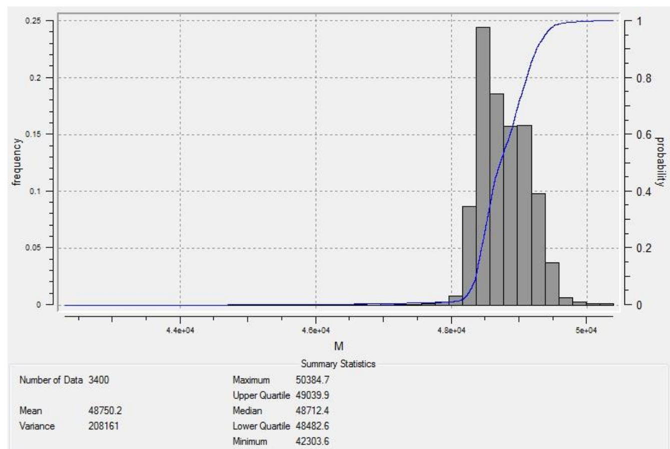

Fig. 7 Histogram and cumulative function diagram of data before normalization

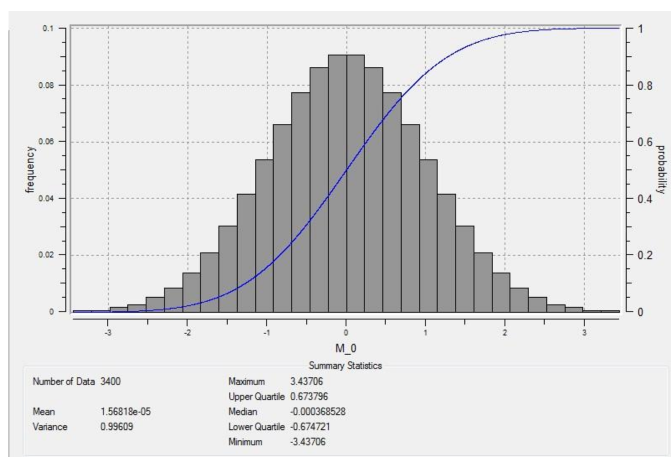

Fig. 8 Histogram and cumulative function diagram of data after normalization

The next step of geo-statistical analysis is to variography in different directions. Between various variographies two of them were selected, one in trend of mineralization (Southeast – Northwest) and next in perpendicular direction which are shown in Fig. 9 and Fig. 10.

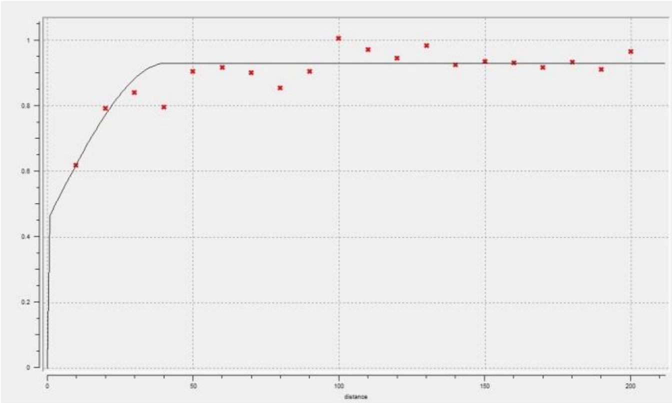

Fig. 9 Variogram in trend of mineralization

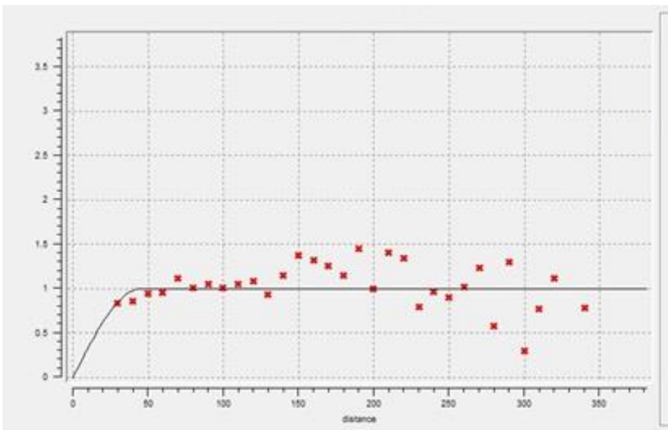

Fig. 10 Variogram in perpendicular trend of mineralization

V. Three dimensional modeling and block estimating

The last step is the three dimensional modeling of data. To crating 3D model a total area is needed in three dimensional spaces. To define this area for data, X (east-west axis) and Y (north-south axis) directions 15 meters and in Z direction (horizontal axis) 5 meters extra space used to estimate blocks completely. Modeling created with ordinary kriging method with 10 meters units of blocks. Numbers of blocks are 178 in X, 116 in Y and 12 in Z direction. The results are shown in Fig. 11 and Fig. 12.

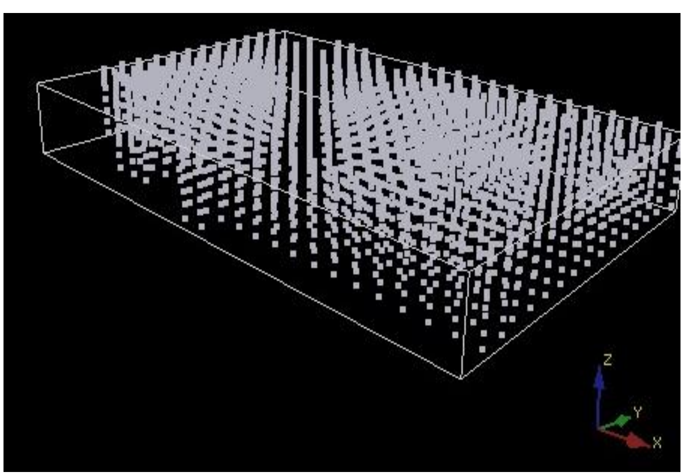

Fig. 11 Three dimensional space of area before block estimating

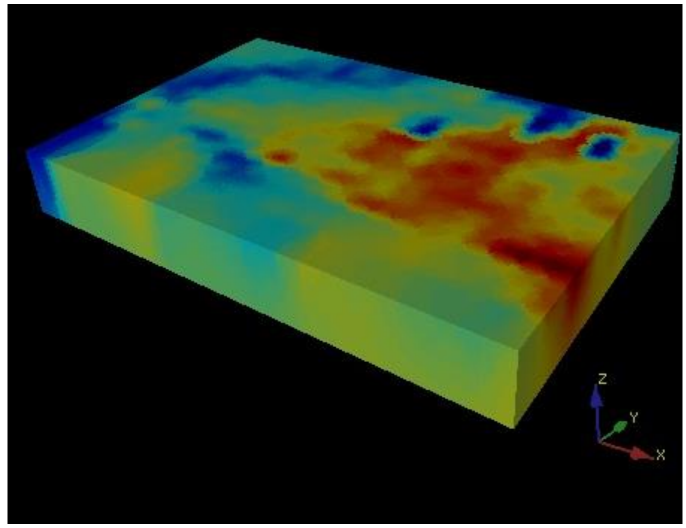

Fig. 12 Three dimensional area after block estimating, view to NW

VI. Helpful Hints

To present 3D geometry of ore deposit, background values were removed and high intensity block were highlighted which are shown in Fig. 13 and Fig. 14.

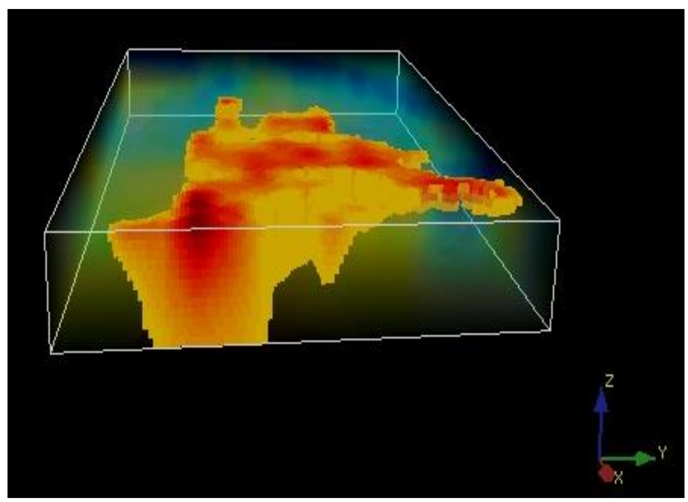

Fig. 13 3D geometry of ore deposit, view to east

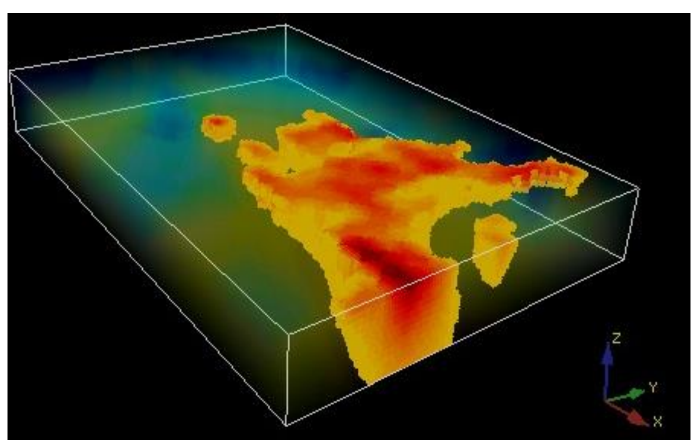

Fig. 14 3D geometry of ore deposit, view to NW

VII. Conclusion

Three dimensional magnetic model of Ghalandar ore deposit was created. This model is only based on magnetometery data. According to this model ore deposit is deeply expanded. Also the model was just based on upward continuation filters in various depths which estimated by ordinary kriging equations. At last it is offer to compare the model with geo-electrical and borehole results to confirm the accuracy of the model.

Acknowledgment

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