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Tectono-magmatic evolution of the Lut block, eastern Iran: A model for spatial localization of porphyry Cu mineralization

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ABSTRACT: The Kalateh'No arc geological zone with its attractive copper porphyry prospect has recently defined in northwest of Gonabad town, Eastern Iran. This area constituted northern part of Eastern Iran Magmatic Assemblage (EIMA) that locating inward of the Lut block. To documenting geological evolution in this area and confirming its copper porphyry potential, all of arc related structural features were studied. During recognition of geological relationships between structurally controlled occurrences and progression of incidents, tectono-magmatic models were defined for this zone in an arc evolutionary view. Based on the geological consequences and with respect to the relative ages of changes in convergence direction, sequences of tectono-magmatic events are modeled at four episodes. Episode I: sinistral transcurrent faulting in response to the clockwise rotation of the Lut block, formation of Gonabad fault and its horsetails in western terminal. Episode II: Tectonic Relaxation, intensive extensional volcanism, and sedimentation in caldera collapse basin. Episode III: change in convergence direction to dextral, formation of a new negative flower structure between branches T3 and T4 of the horsetail and intensive resumption of dextral convergence after quenching porphyry phase, structural sigmoidal opening and injection of late diorite dikes. The last episode to recent; change in convergence again to left-lateral, uplifting and erosion. Based on correlations which are among obvious evidences, this model comprehensively explains regional arc development in northern Lut from beginning volcanism through the arrangement of sub-volcanic porphyry events. Furthermore this model strongly indicates to high exploration potential in defined remote sensing zone. With insisting to geological and structural consequences that are presented here, Kalateh'No zone can be introduce as a complete set of tectonically controlled features that determines copper porphyry localization in a distinct arc landform.

Keywords: Arc magmatism, Sinistral faults, Porphyry copper, Iran.

INTRODUCTION

Following the importance of large scale argillic alterations has long history of kaolin mining coexist with abundant fluorine veins in northwestern of Gonabad town, Eastern Iran; the idea was formed that this area could be an attractive case for remote sensing studies to detecting copper porphyry deposits. After performing remote sensing processes and differentiating large prophylitic and argillic alteration haloes around the central expanded phyllic zone (QSP) with its large gossans and after that during objective field investigations on defined quadrangle, between latitudes 34º 25' N to 34º 32' N and longitudes 58º 25' E to 58º 39' E, Kalateh'No copper porphyry target was identified for the first time in august 2008.

In the last litho-tectonic subdivision of Iran's geology (Walker, 2004) the volcano-pyroclastics of this area formed northern segment of Eastern Iran Magmatic Assemblage (EIMA) that locating inward of the Lut block.
Through predominant calc-alkaline petrology and presence of index ore systems in this assemblage, despite ambiguities about those subduction regimes that formed EIMA, a unanimous consent were posed between researchers about continental arc magmatism for the origin of Eastern Iran volcanic-plutonic belt.

From many years ago association of arc magmatism with major structures and thereupon ore forming systems was prevalently discussed and today it is well proved that tectonic has critical role in localization and position of arc indicator deposits, especially porphyry systems. In other word it should be said that in exploration for porphyry systems, identification of structures which determine subvolcanic plutonism, is one of the first essential key factors. Therefore, understanding of structural controls in local and regional scales is required for precisely detection of porphyry sites (Sillitoe 1972; Vila & Sillitoe 1991; Vrana 1999; Richards, 2001; Richards 2003; Corbett 2012).

With Respect to this important fact, in order to document tectono-magmatic events and clarifying the mechanisms of copper porphyry emplacement in our remote sensing zone, at first step we have analyzed structures on satellite images of Landsat TM, ASTER and SRTM at defined remote sensing zone by using some computer software packages include ENVI 4.2, Arc GIS 9.2, Geomatica V10.0 and Rockworks 14. After field studies, two unveiled systems of fractures were classified and correlated to Gonabad fault in the east of zone as a major structure adjacent to the study area.

By exhibiting direct effects of Gonabad Fault horsetail branches in the study area, based on obtained results from obvious field evidences, an episodic tectono-magmatic model constructed for this area. This model considered relative ages of continuous events include eruptions, subvolcanic prolific emplacement and related alterations and mineralization and consequently late structural emplacement of barren diorites. The model with its clarity has good correlation with authoritative references about tectonics of subduction-related arc magmatism and mineralization, especially cartoon models in Corbett (2012).

Structural analyses of copper porphyry setting at Kalateh'No with other geological investigations, verify that this target has very attractive potential to continue prospecting in detailed subterranean levels on differentiated alterations and its notified structural system.

Moreover, with respect to evidenced observations offered in this paper, we present an explicit view for structural tectono-magmatic arc activities in northern Lut block and also a new theory is coined about an eventual subduction system in northern Lut in resopnse to its clockwise rotation.

Geological Setting

The new explored Kalateh'No zone and its strong copper porphyry target with direct familiarities to arc landforms situated in upside parts of the Lut block in Eastern Iran. This zone with an East-West orientation creates northern part of Eastern Iran continental arc magmatic assemblage that is located inward of the Lut block (Fig. 1).

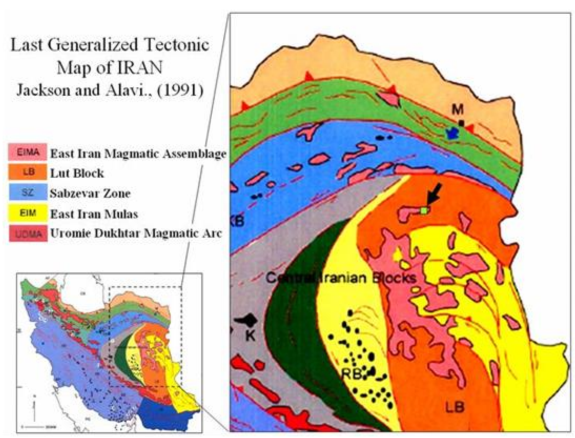

Figure 1. Situation of the Kalateh'No zone is shown in northern part of Eastern Iran Magmatic Assemblage inward of the Lut block

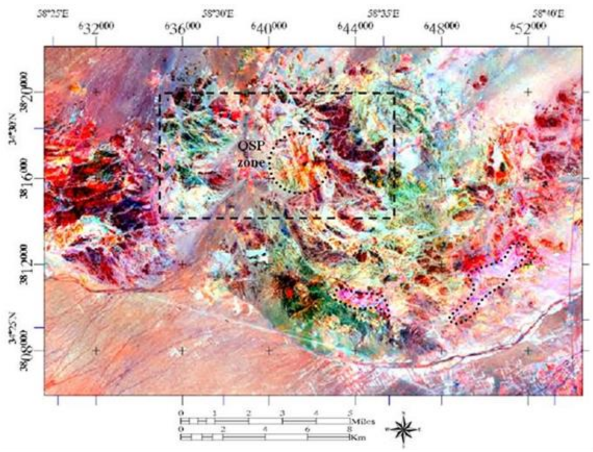

Figure 2. Landsat TM combined band rating Image-Map of the Kalateh'No zone. Large argillic alterations and kaolin mines differentiated with pink color at the right below of the image (see also Fig. 7), green areas mark distinguishing prophylitic haloes. Colored differentiated areas and their mentioned alterations were corroborated with results of alteration identification processes on ASTER images as well as verified through the field studies. After satellite image coordination with field explorations, Kalateh'No porphyry target with its strong prospective QSP zone has intense gossans was defined at dashed line quadrangle (see Fig. 11). As it is obvious, almost whole of the area is altered and index alteration pattern relevant to copper porphyry exploration is well occurring in this zone

This zone that is located between 34º 25' to 34º 32' of northern latitudes and 58º 25' to 58º 39' of Eastern longitudes is laid in western termination of Gonabad fault. Selected quadrangle for remote sensing studies was wisely sorted which encompassed old famous Rokh'Sefid and Ahuee kaolin mines as well as coexisted fluorine veins of Bagh'Siah in the northwest of Gonabad town.

Tectonics and faulting system

The Gonabad fault is a left-lateral strike-slip fault with about 50 Km long in N80°W direction that is active between two main regional structures with same structural manner; Dorune Fault in the northern margin of the Lut block that has about 100km distance and Dasht-e-Bayaz Fault which is located about 40km south of the Gonabad fault (Fig. 3). Because this fault has strike-slip movements occurring throughout a same continental plate, it should be categorized to transcurrent faults that commonly terminating in horsetail structures. Distribution of shear deformation into crust becomes possible in these terminals (Suppe 1985; Pardo-Casas & Molnar 1987; Kearey, 2009). Probably because of attention to just recent conditions of the lineaments, in all of the performed studies on active faulting in Eastern Iran, western limit of this fault was closed before our selected quadrangle. But as it follows, in our episodic evolution model, its horsetail termination has played the major roles in sub-volcanic emplacements.

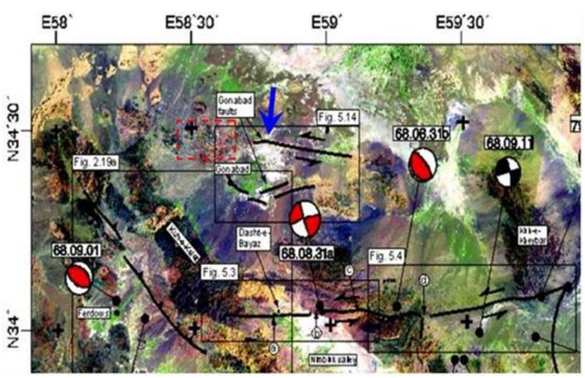

Figure 3. Kalateh'No zone marked with red dashed line quadrangle at west terminal of Gonabad Fault and it is obvious that the end of this fault was closed before our study area (Walker ., 2004). Left-lateral strike-slip faulting is the main activation among the structures in Eastern Iran

Satellite image processing

In the first step by using directional filter with ENVI 4.2 software package on Landsat TM and ASTER satellite images, fractures and possible tectonic lineaments are discriminated in optimum directions (Fig. 4).

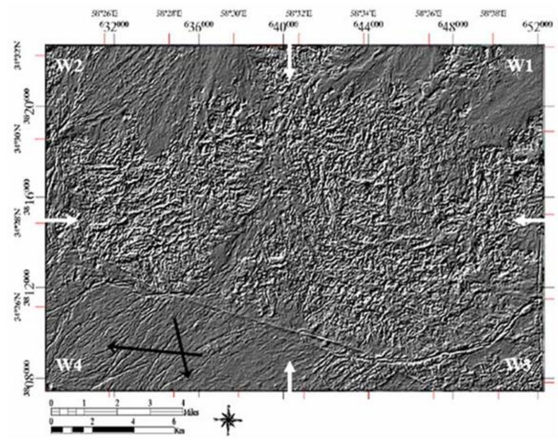

Figure 4. Extracted image from directional filtering on Landsat TM image in ENVI 4.2 software environment. By looking to the fracture pattern that is revealed from this pseudoscopy technique, two main trends of fractures, as are shown below the image, could become differentiated in this zone. White arrows display quadruplet sub zones which used in digital analysis of lineaments on SRTM images

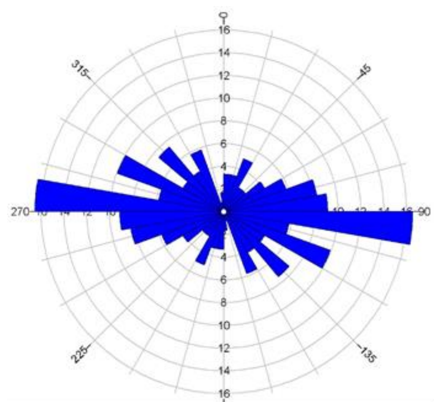

Figure 5. Rose diagram constructed from length analysis of superficial track of lineaments in whole of remote sensing window. Direct influence of Gonabad Fault on main trends of faults and lineaments in Kalateh'No zone is obviously illustrated

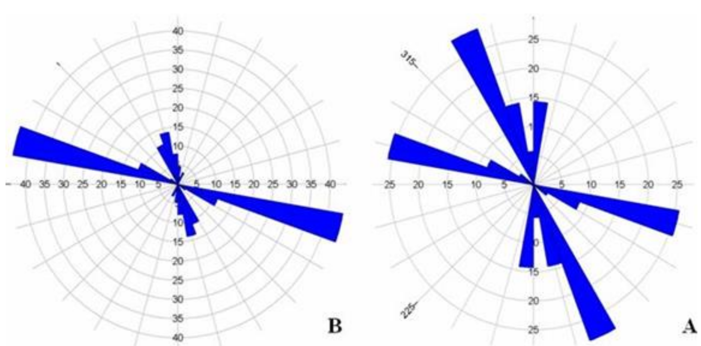

Figure 6. Rose diagram. (A) Frequency analysis of fractures in W1, (B) Length analysis of longer lineaments in W2. Results of this technique along with directional filtering, confirm suggested structural classification for this zone

After exerting this filter in various directions two lineament system in azimuth of 100 and 350 degree are distinguished. This result was corroborated in length and frequency digital analysis of lineaments by using SRTM images in Geomatica V10.0 software package. In addition, structural study of the key features, such as dike injection systems, vein mineralization and linear argillic alterations, confirm the detected direction of lineaments with this technique. This procedure made foundation for structural classification of the study area.

Digital analysis of lineaments

With respect to wide range of remote sensing window and impossibility of gathering a large data set from faults and fractures in the field traverses, and in purpose to revealing straight effects of Gonabad fault horsetail branches activities on the area, lineament extraction algorithm of Geomatica V10.0 and ENVI 4.2 software package applied on SRTM images.

To assessing principal bearings of stress-strain systems and lineament trends, Rose diagrams of extracted data from fracture pattern on SRTM images was constructed by using Rockworks 14 software**.**

In order to optimizing the scale of digital analyzing and feasibility of comparison between obtained results with directional filtering in discrete locations, we have divided the remote sensing quadrangle to four equal windows which are shown in Fig 4. Then we have extracted lineaments and analyzed their basic lengths and frequencies in four sub zones. After the field observations and comparing the obtained trends of satellite image processing, we have found many excellent correlations that verifies development of a typical arc structural system in this area.

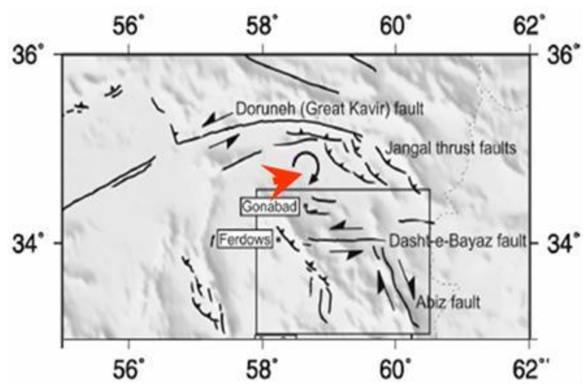

Figure 8. Clockwise rotation of the Lut block and left-lateral activity of the Drouneh Fault at its northern margin, certainly had direct role in transcurent faulting inward of the northern Lut with similar behavior dependent to this system. Schematic map from Walker, (2004)

Classification of structures

After image processing studies, by recognition of fundamental relationships between key linear features and considering the structural pattern of the area, it is possible to classify the structures in two separated lineament categories.

A- First order structures

long fractures and faults with similar trends to Gonabad Fault dominantly at N80°W direction. These structures, which control the morphotectonics of this region, have helped to intensive volcanism and consequently caldera subsidence (first and second episode). After the second episode and through the third episode, subvolcanic emplacements have been done by concentration of tensional-shearing stresses between these structures. In fact, these structures are the horsetail branches and their sub orders of Gonabad fault terminal.

B- Second order structures:

shorter faults and fractures dominantly at N10°W direction that are related to third tectonic episode and returning of compression in opposite direction. These faults and fractures are parts of R' fractures in Reidel shear model that has good adjustment in the study area. These second order structures have crossed and displaced first order structures and linear features such as monzonite dikes (see Fig. 13E).

7. Gonabad Fault horsetails

After classification of structures using satellite image processing and field observations and with respect to configuration of structural features such as large displacements, location of large linear argillic alterations and trends of dikes, we have marked five horsetail branches in the study area which are connected immediately to western termination of Gonabad fault (Fig. 7).

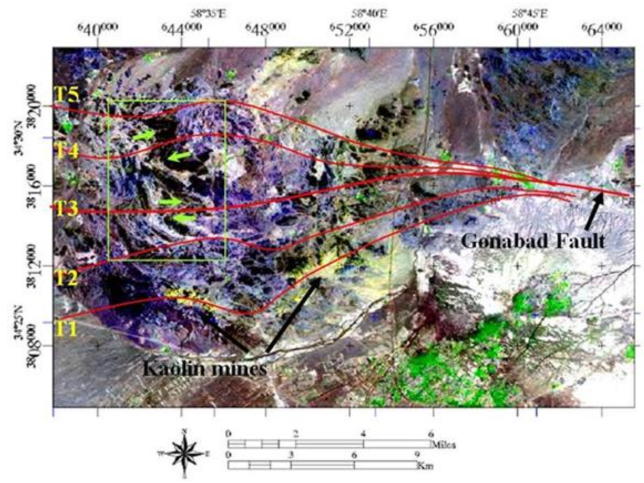

Figure 7. Horsetail structure can be seen on Landsat TM image-map in the right half of defined window overlapped to end of Gonabad Fault. Conjunction of quintuplicate branches with Gonabad Fault was certified at the best style. By readily ascent of hydrothermal fluids through the T1, it is considered as the main structure that has controlled location of faulted argillic alterations and kaolin mines. T3 at the middle of the system which has longer displacement (approximately 3 km), is original branch that directly attached to Gonabad Fault. Large right-lateral displacement during third episode marked in the green quadrangle. Dynamics of these assemblages have been interpreted in sequences of arc evolution model as follow

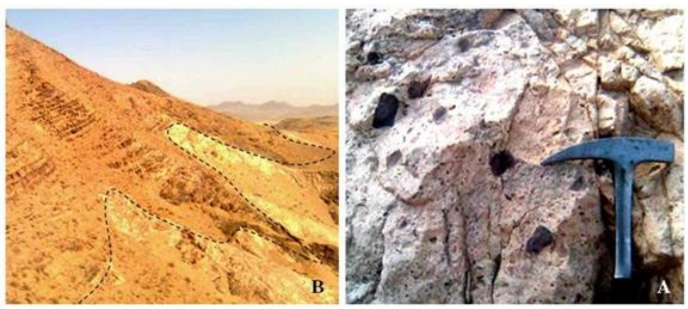

Figure 9. (A) Phreatic Rhyolitic Breccias (PRB) outside of the alteration zone showed with their fresh andesitic fragments. This phase was made up during last generation of eruption in the area. (B) Layered detrital sediments of Caldera Lake with a sharp non-conformity deposited upon PRB after subsidence of volcanic structures

These structures at the Gonabad fault terminal made an occasion cause for distribution of intensive left lateral shear deformation in response to the clockwise rotation of the Lut block.

RESULTS AND DISCUSSION

8.1. Episodic tectono-magmatic modeling

A- Episode I; clockwise rotation of the Lut block, left-lateral transcurrent faulting and formation of Gonabad fault with its horsetail termination:

Central Iran Micro-continent and Lut block at the east of this assemblage encompassed with flysch-molasse zones and ophilite alignments. An important period of Late Cretaceous rifting has allowed the formation of oceanic crust in eastern and northern margins of the Lut block (Ramezani 1997; Besse ., 1998; Soltani 2000; Nezafati 2006; Verdel 2008). The Sabzevar-Torbat-e-Heydarieh ophiolits that are ubducted to north of the Drouneh Fault constitute northern limit of the Lut block. However, subduction system of these narrow oceans has not been defined and fundamental ambiguities are not yet discussed, but in spite of unresolved problems, they are possibly direct sources that subduction of them certainly had critical role in calc-alkaline arc magmatism in Eastern Iran.

Numerous paleomagnetic studies in Central Iran (e.g., Soffel, 1975; Soffel & Forster 1980; Soffel, 1995, 1996) give very large amount of uneven data, but all of them have reached to same conclusion on a complex tectonic phase that Central Iran and Lut block have suffered from a clockwise rotation. Besse . (1998) taking into accounts all pervious works and evidenced large post Triassic clockwise rotations in Central Iran micro-continents. Their studies in Tabas-Birjand and Gonabad areas revealed the 30° clockwise rotation from The Jurassic to the Paleocene in the Lut block.

In except of this paleomagnetic studies, there isn't any published opinion for effect of Lut rotation on probable subduction of its surrounding oceanic crust and arc magmatism in this region.

Our Recent studies in Kalateh'No zone as well as in Taknar plutonic complex that is emplaced in tectonic window of Drouneh fault, revealed many structural indicators which directly specify the ability of clockwise rotation in arc magmatism in northern Lut. Intensification of left-lateral operation of Drouneh Fault that is dependant to continuous clockwise rotation and right-lateral displacement of northern Lut was led to extreme uplifting and deeply crushing of deep plutonic cores such as Taknar complex (Soltani 2000; Rahmani & Kolahdani 2008).

In the most cases of destructive margins, the oblique convergence between plates is most common rather than that uncommon mechanism of orthogonal convergence. Thus, stress transmission of compression with oblique movement of the plates, inevitably synchronizing with shearing. Consequently strike-slip movements of transcurrent faults tectonically controlled magmatic events in volcanic arcs. Domeyko and Atacama faults at western Chile are two prominent examples of controller transcurrent faults (e.g., Richards ., 2001; Richard 2003; Corbett 2012; Richards, 2012).

So, by emphasizing on this clockwise rotation, an eventual subduction system could be introduced in order to consider a particular manner for the origin of arcs in the northern Lut. Furthermore by considering oblique convergences due to this rotation a logical discretion could be organized for the beginning of left-lateral movement of Gonabad Fault as well as Dasht-e-Bayaz fault with similar dynamics to Drouneh fault as controller structure of the northern Lut. Formation of horsetail structure at west terminal of Gonabad fault also easily confirms those harmonies in left-lateral beginnings.

B- Episode II; tectonic Relaxation, intra arc extensional volcanism, caldera subsidence:

More than 70 percent of the study area is covered by acidic tuffs and rhyolites. We know that as a result of high silica content of acidic magma and consequently the high viscosity of them, they move slowly and so light ascent and their intensive eruption just were possible during stretching regimes and structural widening of the continental crust.

On the other hand, today it is proved that arc magmatism occur in a variety of stress regimes and role of tensile strength could be establish in arc continental magmatisms (Zoback 1992; Richards 2003).

According to Hamilton (1995) the common regime above subducting slab is extensional not compressional. Nowadays it is verified that the most parts of the volcanic body in arcs have formed during extensive volcanism in relaxation periods and intra-arc rifting in response to induced extension of slab roll-back (Richards 2003; Corbett 2012).

Through the field observations on huge volcanic sequences in Kalate'No zone, it can be considered that intensive volcanism in horsetail termination of Gonabad fault has occurred during an intra-arc rifting in a distinct period of relaxation.

Beginning and terminating events of long eruption at second episode has been determined according to existent field relationships between the subsequences of volcano-pyroclastics settings.

Exquisite highly prophylitized and strongly eroded andesites that have scarce fresh outcrops and their abundant particles dispersed in covering tuffs, ascribe that eruptional episode in this zone has been started by hydrostatic ascend of intermediate magmas through deep openings of structural corridors.

During continuation of opening, acidic phases from more crustal contamination have reached to near surface conditions and resulted to a new severe pyroclastic eruption course.

Finally, existent non-conformity between caldera lake sediments and lower Phreatic Rhyolitic Breccias (PRB) as a last generation significant eruption exhibits calmness of the area after collapsing the body structure of volcanoes at the end of long flare up second episode.

C.1- Episode III, Part I; recurrence of compression and changing convergence to dextral, formation of negative flower structure between T3 and T4, prolific porphyry plutonism in the root:

Recurrence of compression after a period of tectonic relaxation in magmatic arcs leads to change in direction of convergence in transcurrent faults. Thus the direction of convergence (dextral-sinistral) between two plates relative to the state of convergence pattern before tectonic relaxation will change or orthogonal convergence convert to angular convergence. A set of different performances of strike-slip faults in consecutive periods of compression and extension have occurred in magmatic arcs around the Pacific Ocean (Corbett 2012).

On the other hand, the role of tensional-shear stresses in magmatism between tectonic relaxation periods is determined. Also several reasonable evidences are illustrated from structural studies on many copper porphyry settings that approved sub-volcanic plutons which reached to mineralization stage have been localized due to the oriented shearing (Corbett 2012) and now this theory has been proven that copper porphyry systems mostly have been localized in local tensional positions during recurrence of compression and changing of convergence regime after a period of tectonic Relaxation (Corbett 2012).

Two prominent copper porphyry deposits that are generated with changing convergence conditions after a tectonic Relaxation period are Chuquicamata, Chile (Boric ., 1990), and Frieda River, New Guinea (Leach & Corbett 2008).

Dextral displacement in the time of changing convergence direction at horsetail structure is distinctive in Figure 7. During large scale right-lateral movement of Volcano-pyroclastic masses of the area, the caldera-lake sediments that are related to the end of second episode have been cut by monzonite dikes, and they are systematically altered and hosted mineralization veins. All of these evidences are comparable with a porphyry phase shows a new period of arc activity synchronous to compression during change in convergence direction.

Due to the induction of intensive shear stress and repetition of right-lateral movements in successive branches T3 and T4, the betwixt block has suffered with tear faulting. (Fig. 10).

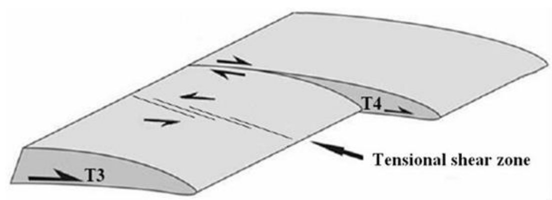

Figure 10. Schematic model and occurrence mechanism of tensional-shear zone and Kalathe'No porphyry localization between T3 and T4

While upper side of T3 had right-lateral movement, the lower side of T4 had been in compression to the left. This repugnance has led to the formation of a new tensional-shear opening system at N70°W direction (Fig. 11).

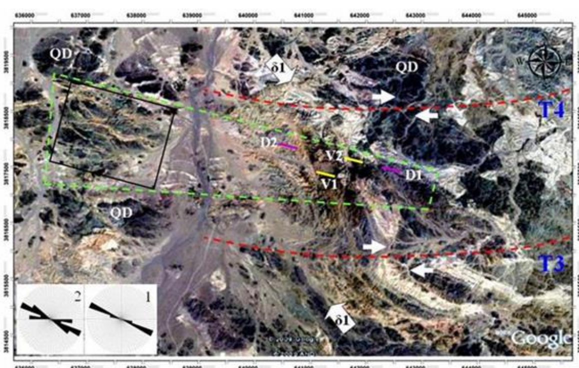

Figure 11. Google earth depicted image of Kalateh'No copper porphyry target displayed in Fig. 2. The Green window shows centralization of tensional-shear zones that host sub-volcanic plutonism by creation a negative flower structure. Violet lines marked big dikes and yellow lines display trend and location of important veins that genetically classified with respect to the buried porphyry system. Rose diagram 1 relates to four monzonite dikes and 2 relate to eight mineralized vein all locating in green window. By considering marked linear argillic alterations at left of green window, whole of correlations which are between porphyry related features will be comprehend easily

Dioritic rocks during their injection into this sigmoid, have intruded in upside as well as downside of the porphyry prospected window (Fig. 11). More opening in this tensional-shear window similarly occurred during intensification of right-lateral convergence due to continuous eastward rotation of the Lut block.

Opening of this system during continuation of repetitive right-lateral shearing caused to creation of a fracturing situation that is make a negative flower structure. This system has controlled the Kalateh'No copper porphyry localization by induction of local tensional shear (Fig. 12).

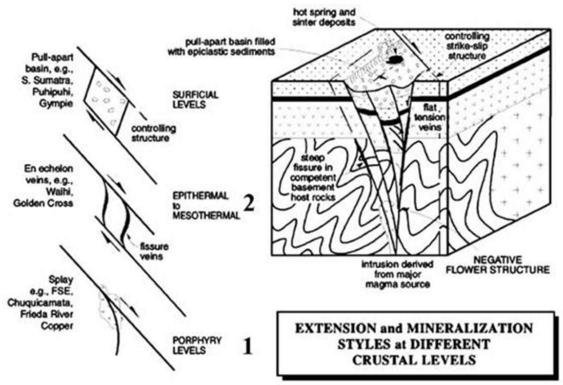

Figure 12. Crustal levels model and low sulfidation veins in Kalateh'No prospect could be assess as the epithermal mineralization level (2) upon a porphyry intrusion (1) in the root of a negative flower structure (Corbett and Leach 1997)

Monzonitic dikes have intruded in general trends of porphyry related features at N70°W direction and show progressive degrees of prophylitic alteration toward center of the system. So we achieved to this idea that prolific sub-volcanic intrusion should be initiated and grown by structural injections of these phases into that openings systems in tensional shear zones. Moreover, linear argillic alterations which occurred in that common direction in the west of negative flower structure, characterized same effects of tensional-shear structures in progression of porphyry phase.

Alteration zonation pattern in Kalateh'No porphyry target have a good consistency with architecture models of copper porphyry systems. In a meaningful order, central QSP alteration gradually led to deeply prophylitized surrounding zone containing intense epidotization and choloritization assemblages. Determining epithermal order of the veins and veinlets based on low sulfidation mineralization paragenesis as well as fluid inclusion studies clearly ascertained their similarities with D type category of porphyry related veins. The clear correlations between these strong evidences verify the present level in Kalateh'No as typical covering blanket upon a good prospected porphyry deposit.

On T4 branch a typical sigmoidal structure is distinct from satellite view through field observations. This feature is constituted by discontinuously injection of diorite dikes into a sigmoidal opening that make an index example of subduction related tectono-magmatic system. Onset of these dikes clearly explains their quite different injection system with respect to the pervious phase of monzonite dikes (Fig. 13 E, F).

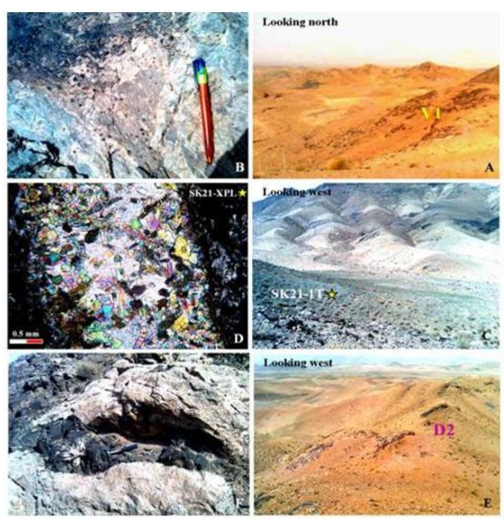

Figure 13. (A) Significant low sulfidation vein-stockwork mineralization zone (V1) with east-west trending at center of the QSP zone. Large gossans that have high Fe oxide ratio are in visible horizon, (B) Bulk silicification and intense pyritization in the QSP zone, (C) Sharp environ of prophylitized andesites around the central QSP altered breccias and their upper caldera sediments. Deep green color of the ground produced from intense choloritization and epidotization, (D) high fluid/rock ratio due to profound prophylitic alteration could be well documented by abundant presences of quartz veinlets includes auto-shape epidotes. Results of fluid inclusion studies in these veinlets along low sulfidation mineralized veins show that they belong to D type veins, (E)

monzonite dike (D_2) with N70°W alignment intruded caldera tuffs in general structural trend of porphyry related features. As it is obvious could see, this dike was displaced by second order structure in N10°W direction, (F) Onset of late sigmoidal fresh diorite dikes intruded in altered acidic tuffs

These dikes with their index system have made a reliable evidence for intensification and continuation of right lateral movements and also clearly states the long period of clockwise movement. In addition, this obvious feature supports our hypothesis about subduction related magmatism in northern Lut due to its clockwise rotation.

C.2- Episode III, part II; intensification of right-lateral shearing after quenching porphyry system, sigmoidal opening and injection of late diorite dikes:

Presence of non-altered diorites that cut all previous altered settings interpreted as the last magmatic event in the area that shows a unique illustration of typical structural arc magmatism. This phase that is the result of rapid hydrostatic ascent of mafic normal calc-alkaline (nor Adakite) magma has an interesting injection system that is conserved during subsequent erosion and tectonic deformations. If a shearing movement continues in a shear zone and if this dynamic be constant for a long period of time, tensional zones that are generated between R and R' parts of Riedel shear model will gradually rotate and consequently open in a sigmoidal pattern (Fig. 14). This mechanism of opening due to oblique convergences in magmatic arcs can be the host of vein mineralization or sub-volcanic intrusions but dependant to crustal level (Fedoseev 2008).

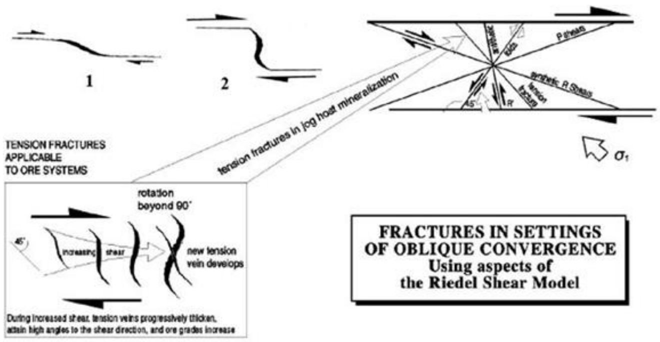

Figure 14. Tectono-Magmatic events in the arcs due to oblique convergence regime.

D- Episode IV; recurrence of left-lateral compression, uplift and erosion to present day:

It was mentioned before that in all recent studies about active faulting in east of Iran, the Gonabad strike-slip fault identified as an active left-lateral fault (e.g., Walker ., 2004; Asadi ., 2013).
This subject clearly states again change in convergence direction and recurrence of left-lateral movement on Gonabad fault and its horsetail branches.

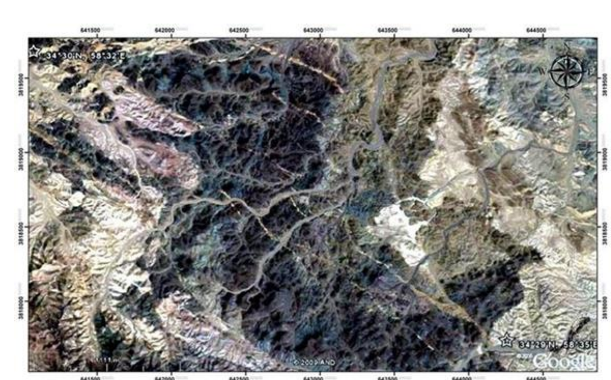

Figure 15. Late sigmoidal diorite plutonism in structural opening on the T4 branch of Gonabad Fault horsetail due to intensification of right-lateral shearing

So after last diorite incidents, arc magmatism in Gonabad arc landform was quenched and the only ongoing processes up today are uplifting and erosion. These processes were getting possible by the left-lateral compression due to induction movement of the Drouneh fault. Widespread outcrop of QSP alteration in Kalateh'No that is certainly occurred in reduced conditions at significant depth indicates high uplifting rate in all over the region which smoothed the topography and it is led to adjacency of the porphyry mineralization level to the present day surface. Weathering and generation of large gossan zones are evidences for uplifting and crossing the QSP mineralization zone from underground water level, so it is also logically expectable that supergene enrichment should have influenced the prospected ore body.

CONCLUSION

During satellite image processing considered to reveal probable prospecting potential related to large argillic alterations in northwest of Gonabad town, northern Lut, index alteration patterns appropriate to copper porphyry exploration have been detected in defined remote sensing window. Then after many satellite coordinated objective field investigations, Kalateh'No porphyry target was recognized for the first time. Determination of sub-volvcanic emplacement system for the Kalateh'No zone, as well as interpretation of its tectono-magmatic evolution, structural analyses were applied by satellite image processing with respect to the filed studies as a basic precursor for copper porphyry quantification. After recognition of structural pattern and classification of the fractures, based on obtained results in the field, Gonabad fault horsetail termination and direct operation of its branches manifested in localization of Kalateh'No porphyry system. Finally, by attention to relative ages of multiple incidents as well as phases of change in dynamic of convergence, events of tectono-magmatic episodic sequences were reconstructed in an arc evolutionary view.

Two plutonic generations, i.e. altered prolific monzonites and fresh barren diorites with completely different structural injection systems were characterized in parts of the third episode that clearly imply to arc structural magmatism in the study area. In addition, offered outlook for the formation of copper porphyry related linear argillic alterations and vein mineralization confirms our definition for Kalateh'No copper porphyry emplacement system. Moreover, with relying on clarity of subduction relationships which are presented in our model, a new point of view can be proposed for subduction system of northern Lut block. Sabzevar-Torbat-e-heydariyeh ophiolite zone, which was ubducted upward of the Drouneh fault, with exceeded 100 km distance to the study area, are remnants of a narrow oceanic crust that has been in north of the Lut block. Many paleomagnetic studies have proven clockwise rotation of the Lut block especially in Gonabad area. Influences of dextral oblique convergence in two generations of sub-volcanic structurally emplacements was discussed in third episode. In this level it is a basic opinion and it should be change to an adopted theory. To do this surely we still need performing many field works and using more advanced techniques as well as many diverse remote sensing techniques.

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