In the name of God

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STRUCTURAL EVOLUTION OF THE TUTAK GNEISS DOME, SOUTHWEST OF IRAN

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STRUCTURAL EVOLUTION OF ACCRETION AND COLLISION PROCESSES OF THE ZAGROS OROGENY, IRAN

BY

AKRAM ALIZADEH

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ABSTRACT

STRUCTURAL EVOLUTION OF THE TUTAK GNEISS DOME, SOUTHWEST OF IRAN

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Reconstruction of the structural evolution of the Tutak gneiss dome in the Sanandaj-Sirjan metamorphic belt contains a history of closure the Neo-Tethyan Ocean, forming the Zagros Orogenic Belt, continental growth through accretion, plutonic emplacement, and of the relative movement and collision between the Afro-Arabian and Iranian plates in transpressional regime. Granitoid emplacement in the Tutak mantled gneiss dome occurred in doubly plunging anticline within the bivergent wedges between two shear faults; the Surian antithetic fault at the north and Mazayjan synthetic fault at the south. The Tutak gneiss dome consists of metamorphosed (Silurian and Devonian) strata, mostly granite-gneiss, marble, calc-silicate rocks, and schists. The foliation is related to the doming, dips radially outward from the core of the dome, but lithological contacts dip towards dome. There are different generations of folds at the study area. In addition, the fold axes (F_1, F_2 and F_3) are gradually reoriented towards the stretching lineation, NW-SE direction, apparently due to the progressive shearing. Megascopic, mesoscopic, and microscopic kinematic indicators confirm dextral sense of shear during the ductile phase of deformation and agree with previous studies which suggested that the ductile shearing occurred during oblique transpressional plate convergence. There are two ^{40}Ar-^{39}Ar age determinations of granites in the core of the Tutak gneiss dome; the earlier belongs to the central Iranian continental crust and has been deformed about 180 Ma in an extensional regime and, the later has been

emplaced in the NE-SW compression in transpressional system. The timing of strain-related fabrics and also the cooling and exhumation history of the region illustrate the continent-continent contact and absolute closure time of the Neo-Tethyan Ocean at about 77 Ma constrained by ^{40}Ar-^{39}Ar geochronology on the biotites of the second stage emplacement of the granite-gneiss in repeated of the orogenic events, demise the Neo-Tethyan Ocean versus alive the Zagros Orogenic Belt.

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Chapter 1

Introduction

1.1. Mantled gneiss domes (*Characteristics)*

Mantled gneiss dome typically consists of a circular, oval or lobate cover of dominantly granitoid rocks surrounded by a cover sequence, or mantle, of metasedimentary and metavolcanic rocks. The granitoid core rocks which may be massive, gneissic, and/ or migmatitic in the central region, are almost invariably foliated and gneissic near the margins. The core may also contain metamorphic rocks of igneous or sedimentary origin, such as mafic and politic schist, amphibolite, and little or undeformed cross-cutting granitoid intrusive rocks that, together with the granitoid gneisses, give the core the characteristic of a deeply eroded basement complex. The mantling strata typically include some or all of the rock type quartzite, conglomerate, marble, amphibolite and metapelite. The stratigraphic succession of these unites is usually uniform within a particular gneiss dome province, but it varies from one province to another. The contact between the core rocks and the mantling strata occurs at a consistent stratigraphic horizon over a wide area. Studies have demonstrated, on the basis of both field relations and radiometric age determination, that in almost every case the contact is an unconformity.

This research deals with the structural, microstructural and kinematic study of the Tutak gneiss dome emplaced in the transpressional setting within the Zagros Orogenic Belt. We use structural, microstructural and kinematic data to show that the location, geometry, and mechanisms of pluton emplacement within

the batholith were controlled by displacements within a network of faults and transpressional shear zones. Our data shed new light on the development of the Tutak gneiss dome within the Zagros Thrust System.

The tectonic significance of the Tutak gneiss dome was laso studied to elucidate the closure time of the Neo-Tethyan Ocean and Arabia-central Iran contact. Crustal thickening is an important phenomenon during mountain formation at convergent continental margins and it reflects how collision is effective in changing the Earth's crust and topography. Detailed description of the tectonic events are presented and discussed in the following section. The new results presented here, favor demise of the Neo-Tethyan Ocean versus forming the Zagros Orogenic Belt.

1.2. Location *(Geographic situation of the study area)*

The Tutak gneiss dome in southwestern Iran part of the Fars province is present in 280 km northwest of Shiraz, and 35 km Bavanat (Surian) region, between latitudes of 30°10′N and 30°35′N and longitudes of 53°20′E and 54°00′ E (Fig. 1.1). The Bavanat region by 480700 m^2 area is the most populated at the study area that ended Yazd province to the east, Neyriz, Marvdasht to the south and Safashahr (Dehbid) to the west.

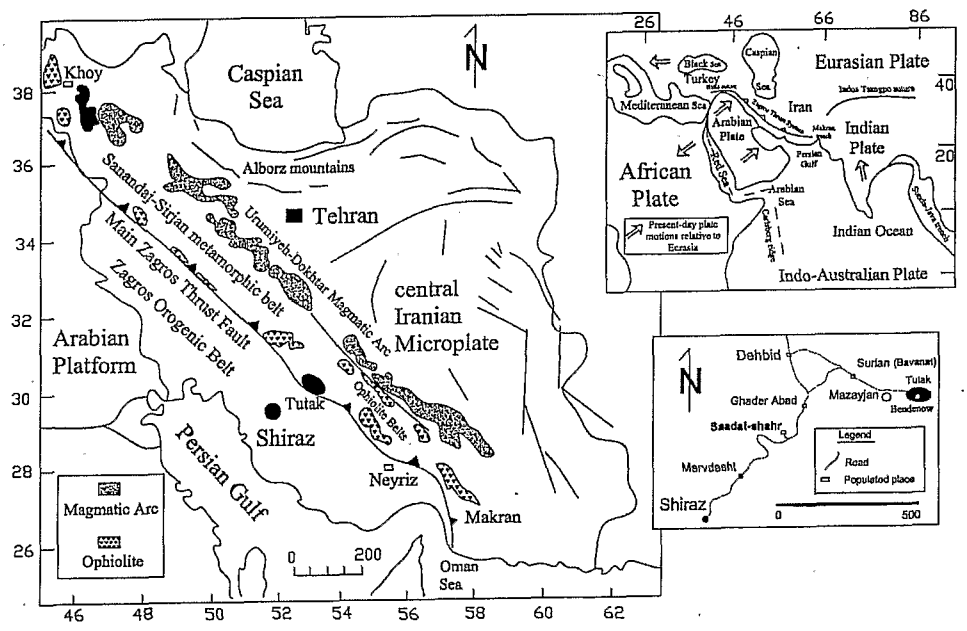

Fig. 1.1. Geographic situation of the study area. The Tutak gneiss dome in the Sanandaj-Sirjan metamorphic belt within the Zagros Orogrnic Belt is located in the southwest of Iran.

The Kuh-e-Sefide Tutak at the Bavanat region is the most important geographic feature of the study area. The highest topography belongs to these mountains that contains thick bedded of marble with 2864 m elevation above the sea-level. The Kuh-e Sefid is a synform anticline along the NW-SE trend and aligned the Zagros Fold-and-Thrust Belt. The Tutak gneiss dome include the granite-gneiss or foliated granites located in the core of these synform anticline and occupied by thick bedded marbles; Kuh-e-Sefid and topographically is less high than these mountains. The topographic low running through the core of the dome is due to the geomorphic expression of easily eroded lithologies and brittle fractures. At the south part of the Tutak gneiss dome, the dips of thick bedded marbles are steeper than the northern part so, the southern part is impracticable to field investigation.

The Bavanat River steams from the northwestern part of area (east of Dehbid region) to southeast, and following to the Munj River at the Yazd province. The Mazayjan river streams almost along the N-S trend from south to north and passes from the Morshedi, Akbari, Chahar-Mahal and Ghalee-Abad villages and at the north, reaches to Bavanat river. Finally at the end point streams along the northwest-southeast direction fallowing to the Munj river, too. As result of various lithological unites the geomorphologic feature is different. For example, the soft and less resistance rocks against the weathering processes inside the anticline have denderitic drainage patterns and the hard rocks (marble) have parallel drainage patterns.

1.3. Previous studies

Harisson et al., (1936), prepared Geological map of the Dehbid area with scale 1:250000, published by Iranian Petroleum Company, contain concise geology of the Zagros and metamorphic rocks of the Dehbid-Mazayjan regions.

Garry (1944), is the first person who studied the Neyriz ophiolote and introduced it as a nappes that overthrusted on the Zagros Orogenic Belt at Cretaceous time.

Alric and Virlogeus (1977), in their investigations entitled on: Petrography and Geochemistry study of metamorphic and magmatic in Dehbid-Bavanat Region, divided the Dehbid's metamorphic rocks into 3 complexes: (1) Heneshk-Gushti; (2) Hassan-abad; and, (3) Tutak complex.

Falcon (1985) has been published a report and described the stratigraphy and structures in the Zagros Orogenic Belt and has been refered to a tectonically deformed zone at the Dehbid area.

Stocklin (1968), in his report about the Zagros, has been subdivided the Zogros Thrust Zone in two zone in-suit Simple Fold Zone at the northwest and overthrust Ophiolitic Zone at the southeast.

Taraz (1972), has been studied the Geology and Stratigraphy of Surmaq-Dehbid region, since Permian to Quaternary.

Ricou (1974), has been subdivided the metamorphic rocks into high-grade (Ghuri area) and low-grade (Ghatruye) rocks. He has introduced Gelo-Maadan zone, as pebbles of conglomerate at Bajosian to Neocomian (early Cretaceous) interval.

Pourkermani (1977), has been studied the tectonics of Sanandaj-Sirjan at the Jurassic and Cretaceous times and introduced eight tectonic phases for Dehbid and Hassan-Abad regions.

The first study on the Tutak Gneiss Dome was by *Houshmand-zadeh et al., (1990)* subjected the 1:250000 Geological map of Eqlid with report. The map was published by Geological Survey of Iran, at 1973. This report carried out detailed studies of the Tutak Gneiss Dome, in lithology, stratigraphy, economic geology and briefly tectonic.

Amini (2000), in his studies on Fe and Mn reservoirs inside the Tutak Gneiss Dome for M.Sc thesis by Prof. Moor, was carried out the possibility and impossibility of exploration for these minerals. He concluded hydrothermal origin for Fe bearing minerals. The host rock of the forming of these minerals in hydrothermal viens is the Kuh-e-Sefid marbles.

Mohajjel et al., (2003), in their paper reconstructed the structural evolution of the Sanandaj-Sirjan metamorphic belt. In this research, subsidence analysis of the Carboniferous to Cretaceous succession of the northeastern Sanandaj–Sirjan Zone near Eglid indicates rifting in the Early Permian followed by a Late Triassic event. Saidi *et al.* (1997) related to subduction along the northeastern margin of Tethys. A major mid Permian marine transgression (Berberian and King, 1981) occurred throughout Iran similar to that in the Arabian Peninsula and these have been related to opening of the southern arm of Tethyan Ocean. The Permian limestones occur in the northwestern part of the complexly deformed sub-zone (e.g. Dorud-Azna region) but evidence for either deep marine sedimentation or rift-related magmatism is lacking. Stampfli *et al.* (1991) interpreted 'thick' Permian limestone, clastics and volcanics in the Golpaygan region as part of the lower plate syn-rift sequence. Metamorphic rocks in the Sanandaj-Sirjan Zone southeast of Sirjan (including the metamorphics around Esfandageh) have also been related to Carboniferous-Permian taphrogenesis (Stampfli et al., 1991). These metamorphic rocks are overlain unconformably by Jurassic rocks but their significance remains to be established (Stocklin, 1981). If these rocks were related to rifting they would presumably form a metamorphic core complex but they are potentially related to either Hercynian orogenesis or convergence after the opening of Tethys.

Baharifar et al., (2004), have been studied the Crystalline Complexes in Sanandaj-Sirjan Zone. At this study, Tutak complex has been introduced as a Metamorphic Dome was formed as a result of the major continental extension.

One of the few structural studies on Tutak complex was carried out by *Nuri (2004),* in his doctoral thesis by supervision of Dr. Sabzeii and Dr. Abedinie. He has been studied the Petrology and Petrography of the Tutak gneiss dome. In this study, he is rather concentrated on the petrological and petrogenesis of the Tutak complex rock and briefly tectonic structures. He concluded that Bon-Dono gneisses are exposed in the core of Tutak anticline. The Tutak metamorphic complex or the host of these gneisses is part of the Sanandaj-Sirjan metamorphic belt. Field studies have shown that: (1) the age of protoplast of this complex is Upper to Lower Paleozoic. It is comprised of various mechanisms, amphibolites, marbles and greenschists. They metamorphosed in pre-Upper Jurassic metamorphic event. (2) Tutak complex had been invaded later by a granitic body. These regional metamorphic rocks had been subjected to a contact metamorphism resulted from this intrusive magma. (3) Primitic body had been subjected to mylonitization in a shear zone and converted to the so-called-Bon-Dono Gneisses. Field and geochemical studies all indicate magmatic nature of original protolith of so-called Bon-Dono gneisses.

The latest study on the Tutak complex was by *Kolahiazar (2005),* in his M.Sc thesis with supervision of Dr. Sarkarinejad, also carried out the structural and microstructural aspects of the Tutak complex. In this study, some parts of study area, has been investigated at microscopic scales. He concluded the Tutak complex that is suited at Sanandaj-Sirjan metamorphic belt, mylonitized and crushed subjected to shearing. Two normal listric faults bounded the dome at the north and south of the Tutak complex. The shear sense indicators at the study area illustrate the shearing with dextral component.

1.4. Purpose and Scope

Field geologic mapping, structural analysis of microstructures and petrofabrics, and metamorphic facies were undertaken to resolve the crustal conditions and tectonic mechanisms of metamorphic and deformational activity. The specific objectives and purposes of this study are as follows: