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IN THE NAME OF GOD

CLASSIFICATION OF ZAGROS KARSTIC AQUIFERS BASED ON  
GENERAL DIRECTION OF GROUNDWATER FLOW AND PHYSICO-  
CHEMICAL PROPERTIES

BY

JAVAD ASHJARI

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*To angels,*

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## ABSTRACT

# CLASSIFICATION OF ZAGROS KARSTIC AQUIFERS BASED ON GENERAL DIRECTION OF GROUNDWATER FLOW AND PHYSICO-CHEMICAL PROPERTIES

BY

JAVAD ASHJARI

Seventy two of the Zagros karstic anticlines were divided into two main groups based on the hydrogeological relationship of the flanks. The geological settings are the main controlling factors in these two groups. Each group was further classified into four subgroups based on the location of the discharging zone(s), namely one or both plunges, flank(s), traverse river, and combination of plunges, flanks and river. The discharging zone(s) are mainly controlled by the local base level. The main factors controlling the general direction of flow are thus determined to be the local base level, and the lithological and geological settings. Based on the geometry of the anticline and outflow position, a conceptual model is presented for delineation of the flow direction, at least within the Zagros Range. Hydrochemical data from 195 karst springs emerging from 5 different karstic formations in the Zagros region were classified based on the water type, major ions and specific conductance. The main factors controlling the groundwater composition are lithology of the neighboring formations, the salt domes and saline water from adjacent lakes or alluvium aquifers.

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## **Chapter One**

### **Introduction and Literature Review**

## 1-Introduction and literature review

### 1-1. Introduction

Karstified rocks can be found in all parts of the world. Karst is estimated to cover 20% to 25% of the surface of all continents (Bonacci, 1990). In Iran, Karstic carbonate formations outcrop in about 11% of the land area, with a total area of 180,000 km<sup>2</sup> (Figure 1-1).

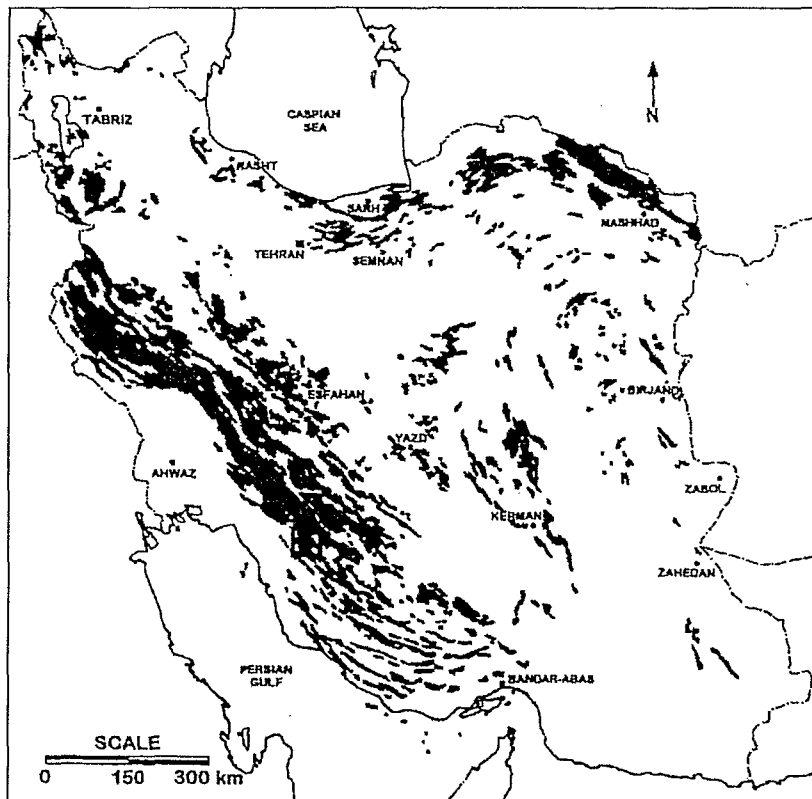


Figure 1-1: Map of carbonate formations distribution in Iran (Naseri 1991).

Carbonate karstic formations outcrop in about 23% of the Zagros Mountain Range (Raeisi and Kowsar, 1997). The hydrogeological studies of

Zagros were started in Iran, and were mostly carried out by Shiraz University, the Karst Research Institute of Iran and Ministry of Energy. Most of the karst studies in Zagros have focused on the central-south of Iran (Fars Province) and a few studies in the west of Iran (Illam Province). These studies are based on the researches such as: Naseri, 1991; Jahani 1993; Rajaei 1999; Rezaei 1998; Eftekhari 1994; Kowsar 1995; Pezeshkpour 1991; Raeisi 2002; Raeisi et al., 1993, 2001, 2003, 2005; Raeisi and Karami 1996, 1997; Rahnemaie 1994; Karst Research Institute of Iran 1993, 1995, 1996, 2000; Nejati 1992; Milanovic and Aghili 1990; Asadi 1998; Asadpour 2001; Johnparvar 2001; Favakeh 2006; Rahimi 2006; Keshavarz 2003; Karimi-Vardanjani 2003. The general flow direction was only determined in a few anticlines in Zagros Range, but the controlling factors on the general flow direction have not yet been studied in the Zagros karstic formations.

Folding is the main characteristic of the Zagros Range. Karst formations in the Zagros are usually sandwiched between impermeable non-carbonate formations, forming independent highland aquifers. The overlying and underlying formations are composed of marl, gypsum while the interlayers are halite in some parts of the Zagros, causing a reduction of karst water quality. Salt domes are in direct contact with karst formations in some of the anticlines, deteriorating the quality of karst water. Intrusion of saline water from an adjacent lake or alluvium aquifer into a karst aquifer is another source of water quality reduction in the Zagros.

## **1-2. Aims and objectives**

The main objectives of the present research are as follows:

- 1- To determine the typical general flow direction and its dominant controlling factors;
- 2- To present a scheme of classification of karst springs in the study area based on general flow direction and hydrochemical characteristics;