



# Devonian palaeobiogeographic affinities of Afghanistan and surrounding areas (Iran, Pakistan)



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## ABSTRACT

Palaeozoic (Devonian) outcrops in Afghanistan and neighbouring countries (Iran, Pakistan) are numerous but very sparsely distributed, and poorly known. The first interpretation, based on rare or poor data considered these North Gondwanan terranes as poorly connected and some authors have suggested the presence of large oceanic domains in palaeogeographical models. Increase in knowledge, especially of the distribution of main fossils groups, and also some lithological similarities, allow a review of the preliminary models and the identification of connections between the different terranes. For example the presence of Fistuliporid Bryozoan beds or rich *Receptaculites* levels in different sections of the three countries, especially in the Dasht-e Nawar and Central Iran areas, allows the preliminary models to be reviewed and the connections among the different terranes to be clarified.

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## 1. Introduction

Several large palaeogeographic units are recognized during Devonian along the northern margin of Gondwana collectively known as the Cimmerian terranes. These units are generally delimited by significant tectonic discontinuities, and those terranes largely cover today's Afghanistan, Iran and Pakistan (Fig. 1).

The difficulties to precise the northern margin of Gondwana were underlined more than thirty-five years ago (Blant, 1978). For instance, Montenat et al. (1978, Fig. 1, p. 288) pointed out the uncertain structural position of the “Domaine intermédiaire” (=Band-e Bayan) in Afghanistan.

In some of those terranes Palaeozoic rocks crop out, and the Devonian rocks have been intensively studied for more than 150 years. Devonian studies began in Iran, and subsequently Devonian rocks were discovered in Afghanistan and Pakistan.

Curiously the most extensive sites are located in Afghanistan, yet they were discovered the most recently. This is why numerous synthetic studies have not taken into account data from these outcrops. Here we present a comprehensive analysis of all data from the Devonian of Afghanistan and compare them with Iran and Pakistan.

The three areas are as follows.

## 2. Afghanistan

### 2.1. History of the discovery of Devonian rocks in Afghanistan

In Afghanistan (Fig. 1) Devonian outcrops have been progressively discovered and studied since the end of nineteenth and beginning of the twentieth centuries. Griesbach (1885, 1887a,b) was the first who noted Palaeozoic (Carboniferous) rocks near Tagareh, Robot-e Paï area, which is located in the Band-e Bayan, also called the Axial Zone (see later). Hayden (1909, 1911) described Devonian outcrops in the Hajigak area (also located in the Band-e Bayan). Maillieux (1940) published some Upper Devonian fossils collected in Zindajan section, near Tagareh Kaftar, West of Herat, (Robot-e Paï area) near the Griesbach's locality.

However, the most important and largest Afghan Devonian outcrops, in Central Mountains (sometimes also called “Hazarajat”) have only been discovered more recently. Thus, in Furon's map (1941), the area appears as a white zone with a large question mark; however he gave important observations on some of the other Afghan areas.

Menessier (1961) gave only two places in the Upper Devonian in Afghanistan: near Herat, and in the eastern part of Koh-e Baba. He considered that this last outcrop extended up to the Penjchir Valley, as unfossiliferous beds, underneath the hematitic beds attributed by Furon (1941) to the Lower Devonian. Martina (1963) discussed a possible Devonian age, but Hinze (1964) concluded a Devonian age for “Hajigak limestones and haematite”.

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Later, [de Lapparent \(1971\)](#) gave an early Palaeozoic age for the hematitic Hajigak beds.

From the beginning of the 1960s to the end of the 1970s years, several geological teams (Afghan, French, German, Soviet and Italian, then later Afghan and Soviet) worked in different places in Afghanistan, with lot of publications. As a result of the diversity of the teams, the names of the different recognized Zones, areas, formations, and localities frequently differ and are often difficult to correlate.

[de Lapparent and Le Maître \(1963\)](#) described a rich Frasnian and Famennian fauna from the Devonian at Zard Sang, a locality located at about 100 km west of Hajigak, the third outcrop discovered in Afghanistan. [Martina \(1963\)](#) described in detail the Hajigak section recognized by Hayden and gave also description of a new section at Rangar, near Ghorband, 100 km east of Hajigak. [Weippert and Wittekindt \(1964\)](#), cited by [Dürkoop \(1970\)](#), identified some Devonian (Eifelian) outcrops in “Hazarajat”, but in reality that new locality is also located in the Band-e Bayan, near Zeri Kotal, about 20 km north of the central track Kaboul-Herat, and thus not really in “Hazarajat in a narrow concept” i.e. Central Mountains (see later). Devonian outcrops in the Central Mountains were discovered and described for the first time by [Fesefeldt \(1964\)](#), and [de Lapparent et al. \(1964\)](#). The latter authors described a Middle Devonian (Eifelian and Givetian) fauna in the Doni Yarchi section, North of Dasht-e Nawar, and possible Middle Devonian near BehSud. [Fesefeldt \(1964\)](#) gave a description of a complete Devonian succession near Said-Habib, in Dasht-e-Nawar (=Dasht-e Nawar), and referred to the “Hajigak serie” or “Hajigak Formation”, but that name appears to be incorrect because Hajigak is located in the Band-e Bayan. Also in the same year, [Desio et al. \(1964\)](#) described the Upper Devonian Kalawch Limestone Formation, with arenaceous and fossiliferous beds, in Badakhshan.

To conclude, the Middle Devonian in Afghanistan was pointed out for the first time in the same year, by [Fesefeldt \(1964\)](#) and by [de Lapparent et al. \(1964\)](#), in the Central Mountains and by [Weippert and Wittekindt \(1964\)](#), in the Band-e Bayan.

During the following years, many papers were published. [Brice \(1965\)](#) described a stromatoporoid fauna from several outcrops in the Band-e Bayan (Zard Sang, Rukh, Kadjao) and the Central Mountains (Doni Yarchi). [Blaise \(1968\)](#) described a shaly and calcareous azoic succession, in the North (Maïdan axe, Koh-e Paghman, Koh-e Sanglakh) and pointed out the probable extensions of fossiliferous Devonian limestone at Koh-e-Sadmarda. [Jux \(1969\)](#) described Frasnian reefal levels in “Hajigak Folge”, near Caraghsang, Daste Nawar (= Dasht-e Nawar) in Central Mountains. [Dürkoop \(1970\)](#) and [Plodowski \(1970\)](#), published their theses on the Devonian of Central Mountains (South Dasht-e Nawar) and Band-e Bayan (Rukh) with studies of brachiopods and conodonts. [Brice \(1971\)](#) listed eight areas where the Devonian is present in Afghanistan, gave precise location of outcrops and described a rich fauna of brachiopods and rugose corals. A special volume devoted to the geology of Afghanistan published in 1972, includes several syntheses, many of them on the Devonian ([Blaise, 1972a; Blaise, 1972b; Blaise et al., 1972; Desparmet and Montenat, 1972; de Lapparent, 1972](#)). [Wittekindt \(1973\)](#) published a map with the locations of the different areas studied and mapped by different authors. [Wolfart and Wittekindt \(1980\)](#) gave large faunal lists and a bibliography with more than 680 references.

## 2.2. The different structural units recognized in Afghanistan

Historically, there has been some disagreement or confusion related to the different structural units recognized in Afghanistan by different authors. By the beginning of 1970s ([de Lapparent, 1972; Termier and Termier, 1977; Bordet, 1980; Vachard, 1980; Boulin, 1981a,b; Mistiaen, 1985; Vachard and Montenat, 1996; Bouyx, 2010](#)) it has been possible to recognize, from the North to the South, a succession of very different domains as follows ([Fig. 2](#)):

- The Northern Afghanistan corresponding to southern part of the molassic Turkestan Basin.

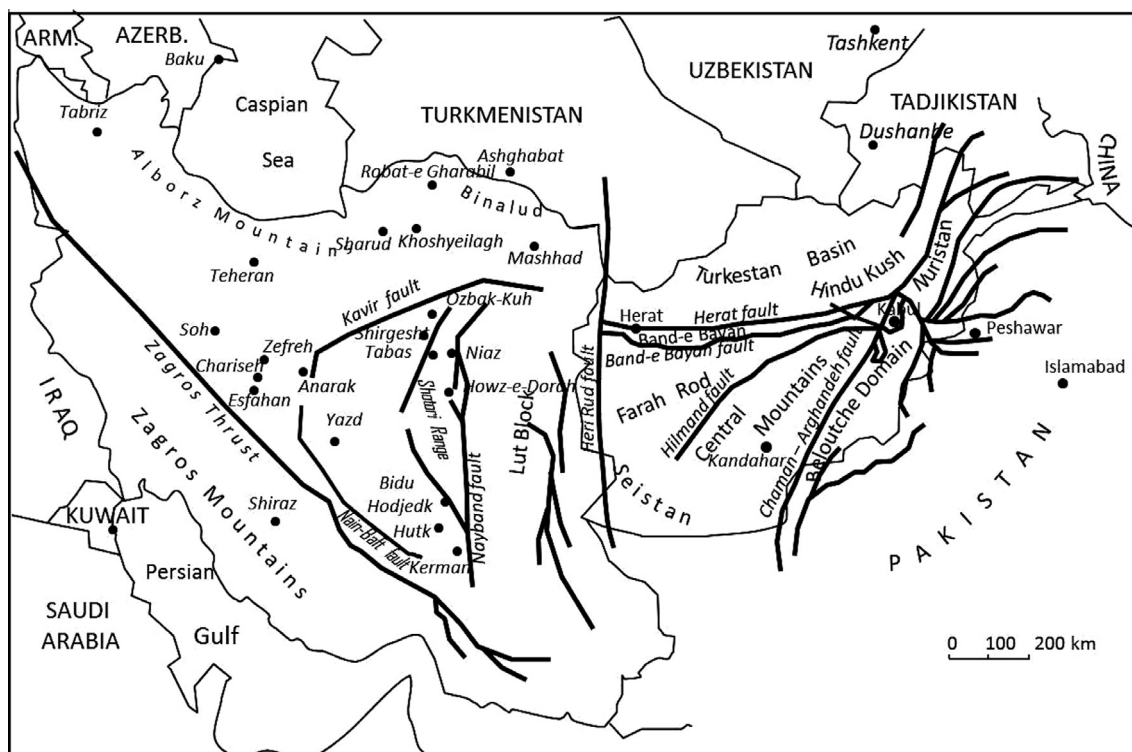


Fig. 1. General map (Iran, Afghanistan, Pakistan) with location of principal areas and localities.

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