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The age of the blueschists and the Indus-Kohistan Suture Line, NW Pakistan

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Geologia. — *The age of the blueschists and the Indus-Kohistan Suture Line, NW Pakistan.* Nota di ARDITO DESIO (*) e F. A. SHAMS (**), presentata (***) dal Socio A. DESIO.

RIASSUNTO. — La nota riguarda la datazione ottenuta con metodi radiometrici degli scisti blu (scisti a glaucofane), i quali risultano di età turoniana (84±1.7 m.a.). Tali scisti blu, scoperti sul Shang-la e nelle immediate vicinanze, fra la valle di Swat e quella dell'Indo, dai due autori contrassegnano la prosecuzione occidentale a ovest del Nanga Parbat, della «Linea dell'Indo» ben nota e intepretata come cicatrice corrispondente in superficie alla giunzione fra la zolla indiana e la zolla euroasiatica.

The chaotic occurrence in the Late Cretaceous Flysh of ultramafic rocks and huge exotic blocks of sediments, with Permian to Late Jurassic pelagic fauna in the Kiogar–Chitichum area of the Indo–Tibetan border has been known for quite some time [1–3]. Similar occurrences were located further east up to Lake Manasarowar more or less following the Indus River valley [4–19] (Fig. 1). Due to associated phenomena of root-like downbuckling with orogenic effects, considerable tectonic significance was attached to this narrow belt, the so-called Indus Suture Line [4]. More recently a similar line was identified [7] also to the west, along the southern border of Kohistan, as far as the Afghan frontier and beyond (Fig. 2), and also to the north (Shayok–Hini–Drosh line) [20].

Between the two segments of the originally continuous line is inserted the Nanga Parbat–Haramosh massif with a north-northeast trend, an orographic and tectonic element which represents an outlier of the old Indian Platform. It intrudes as a huge wedge into the Tethys–Karakorum structures which are mainly oriented east-northeast and strongly divert the Indus–Kohistan Line toward north. The Indus Suture Line to the east of the Nanga Parbat–Haramosh massif was accepted to represent a replica of oceanic crust most of which had disappeared during underthrusting of the Indian Platform against the Tibetan block, causing considerable crustal shortening [4–6]. This position has been introduced also in the theories of plate tectonics [9–11], recognising the Indus Suture as the fossil trench that existed prior to the continent-continent collisional episode of orogenic evolution of the Himalayas. The same interpretation was given to the whole Indus–Kokistan Line, extending to the west of the Nanga Parbat–Haramosh massif [7–9 and 20].

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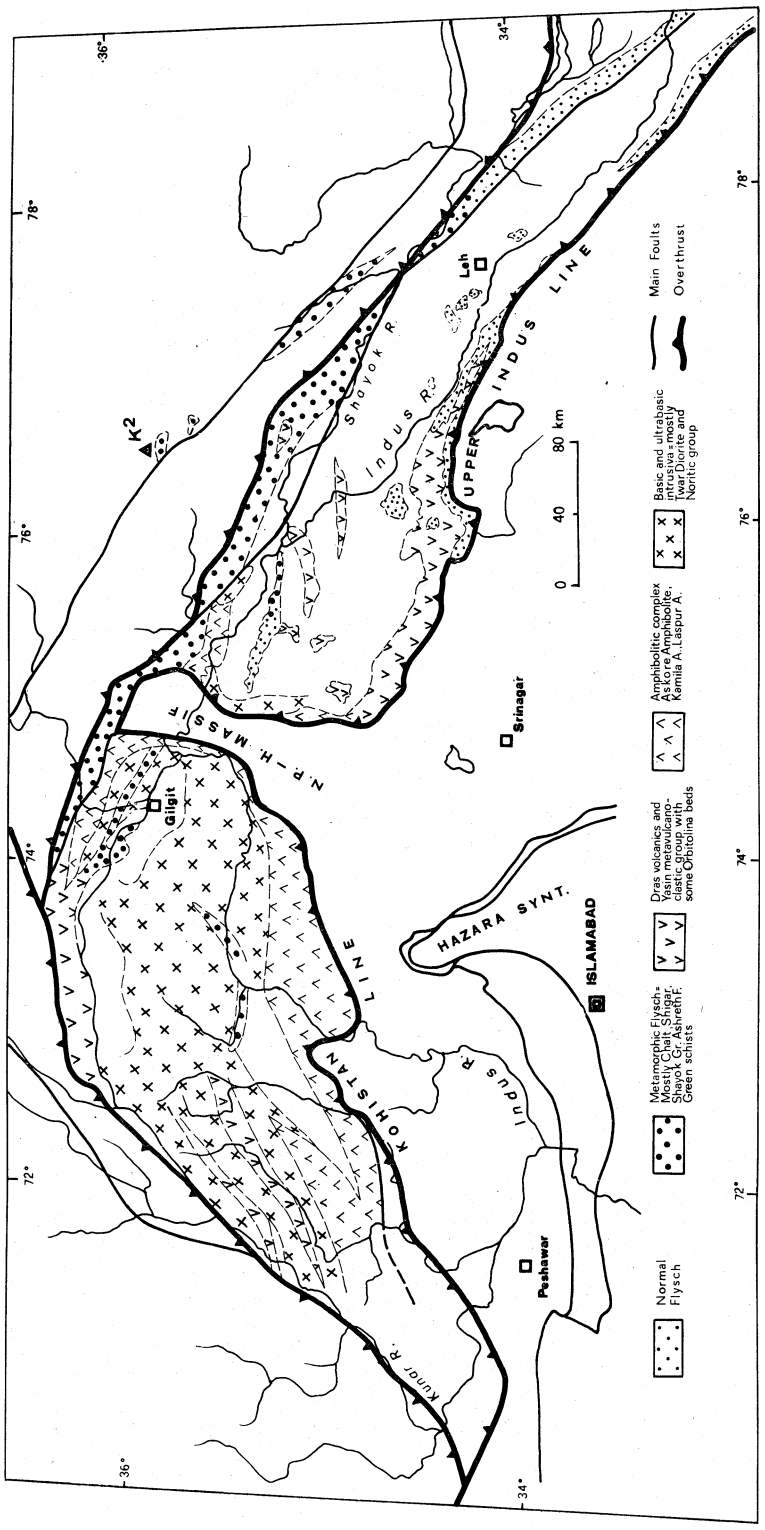

Fig. 1. - The Ophiolitic Belts and the Indus–Kohistan Line (according to Desio).

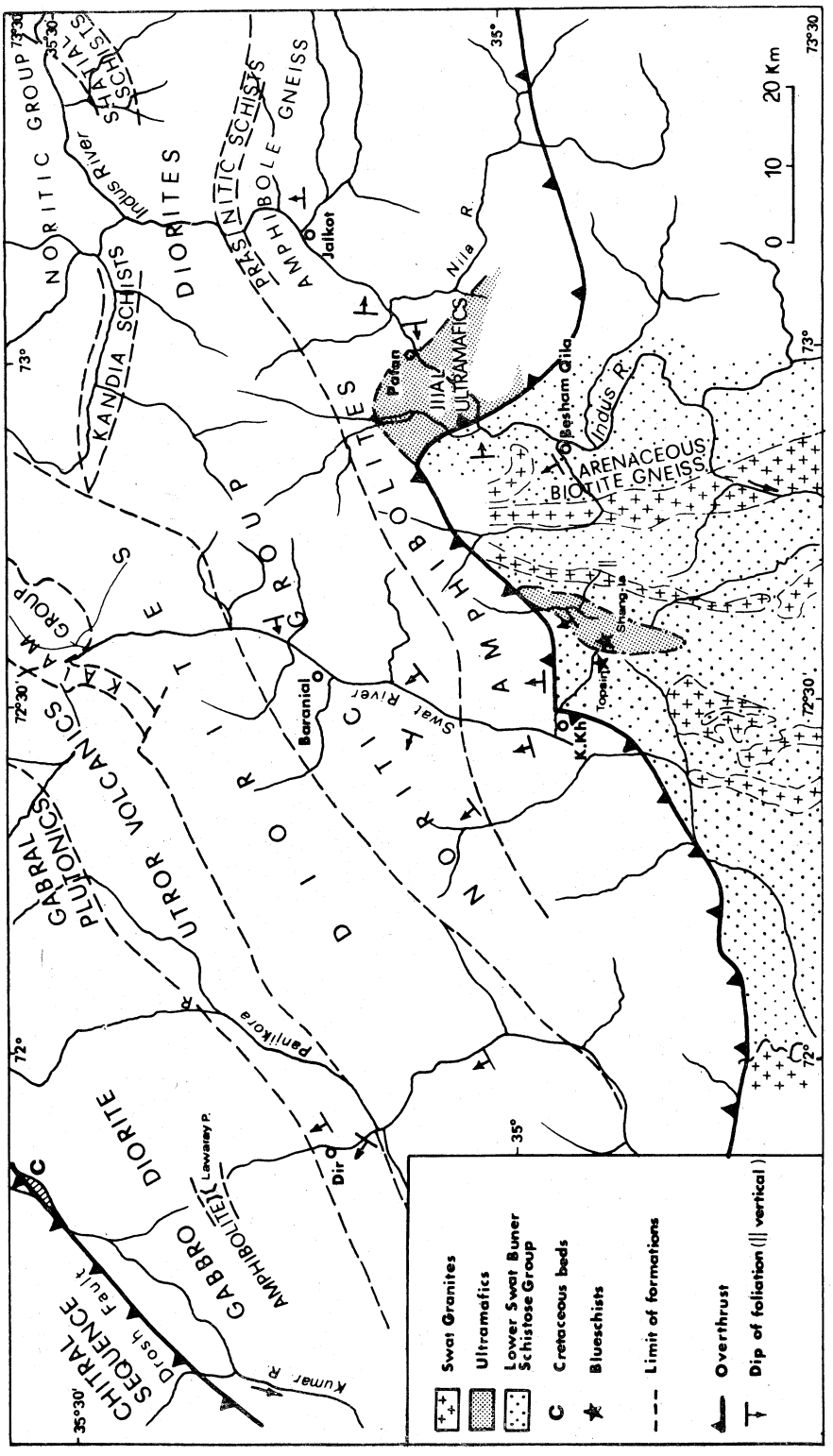

Fig. 2. – The Western Section of the Kohistan Line and the location of the Glaucophane Schists (according to Shams 1972, Desio 1974–1977, Jan and Kempe 1973, Tahirkheli and Jan 1978).

Recently, however, this concept has fallen into major controversy and opinions vary widely. Nevertheless, recent discovery of blueschists in the western sector of the Indus–Kokistan Line give fairly conclusive support to the above-mentioned interpretation.

Blueschists were first discovered by Shams [13] near Topsin (Lat 34° 53,5′ N; Long. 74° 35,5′ E), and by Desio [7–9] in a nearby locality at Shang-la (Fig. 2). Three varieties of blueschists from Topsin have been identified so far, brief descriptions of their typical examples being given below along with point-counter modal percentages:

Type I: Greenish-gray schistose rock, composed of quartz (40.7) albite (24.8), muscovite (30.3), garnet (4.0), epidote (1.2) and tourmaline (0.5), with glaucophane (12.2) associated with interwoven micaceous folia.

Type II: Dark bluish-grey schistose rock, composed of albite (15.2), muscovite (13.1), quartz (3.9), epidote (0.15, and rutile (0.5), with glaucophane (65.8) associated with mat-like intergrowths of muscovite flakes.

Type III: Dark bluish-black dense rock, composed of coarse-grained epidote (44.5), garnet (13.3) and minor rutile (0.5), with glaucophane (42.2) forming clusters of big crystals.

TABLE I.

Chemical composition of glaucophane rocks from Topsin (Shang-la), Swat.

	Type I (14330)	Type II (14348)	Type III (14363)
SiO_2	56.47	74.31	47.71
TiO_2	0.22	10.18	0.24
Al_2O_3	17.20	11.67	18.20
Fe_2O_3	3.60	0.80	8.89
FeO	3.60	2.16	4.97
MnO	0.24	0.32	0.26
MgO	5.34	1.77	5.62
CaO	2.85	1.60	9.52
Na_2O	7.20	3.25	2.96
K_2O	2.55	3.12	0.30
H_2O	0.42	0.34	0.46
Total	99.69	99.52	99.13

The blueschists types I and II are of metasedimentary origin, while type III is a metadolerite. The type from Shang-la is somewhat different from the Topsin lithotypes. It is a chlorite-glaucophane schist with plagioclase, glaucophane, chlorite, epidote and opaque minerals as components. It is to be compared with Topsin types I and II rather than with type III.

All these rocks are included in the Lower Swat–Buner Schistose Group of Palaeozoic age [14], other members in the vicinity being quartzose micaschists, phyllites and greenschists. The eastern extension of the blueschist lithologies are in tectonic relationship to an alpine-type serpentinite body displaying features like an obducted mass [15]. In the north outcrops a portion of the so-called Upper Swat Hornblendic Group [14] which is composed of dioritic to noritic rocks (Middle Indus Noritic Group of Desio [7]), which have suffered metamorphism up to granulite facies [16]. The marginal portion of this group is foliated and is composed of amphibolites, some of which are recognised to be metamorphosed tuff flows [17]. The contact between schistose rocks and the Noritic Group is thrust-faulted and is marked by the Patan fault which represents a section of the Indus–Kokistan Line. This important tectonic line continues eastwards to Babusar pass where it takes a northwards trend and swings around the Nanga Parbat–Haramosh massif [8–18].

The petrotectonic conditions represented by the blueschists of Shang-la could be expected to have prevailed all along the Indus Suture Line which has recently yielded some new occurrences [19]. The incomplete field observation is to be considered the main reason for rare identification of the blueschists to the east of the Nanga Parbat–Haramosh massif.

By way of certain stratigraphical reasonings, a Palaeocene age was attributed to the "Shang-la Blueschists" [9]. For the Indus area Pilger and Rössler [23] proposed an older age (77–70 m.y.). Muscovite from a Topsin sample, however, yielded a radiometric age of 84 ± 1.7 m.y. i.e. Upper Cretaceous (Turonian). This is in significant agreement with the age of hornblende from a diorite pegmatite belonging to the Upper Swat Hornblendic Group [16], only about 40 km NNW from Topsin. This age range falls within a proposed period [12] of convergence of Indian plate and Tibetan block between Valanginian (130 m.y.) and Maastrichtian (65 m.y.). The present geographical location of the Shang-la blueschists, however, is assumed to depend on tectonic evolution of the northwards drifting Indian plate.

We must add a brief consideration on this subject. It has been proposed that subduction of the northern sea floor of the Indian plate should have started [21] when the Indian continent was still close to Madagascar and at a distance of not less than 3500 km from the southern border of the Eurasiatic continent. This distance may be taken to represent the width of the Tethys sea during that period. If we consider the width of the Tethys to have become about 2000 km at the Maastrichtian time (70 m.y. age), we deduce that over the 14 m.y. period the Indian continent migrated northwards for about 1500 km, that is 107 km per million years or 10.7 cm per year. This rate of displacement is in harmony with the rates calculated for the preceding and following ages.

It has been suggested also that phenomena related to "Tethys geosyncline, ophiolites, sea floor spreading, trench, island arc, subduction and glaucophanitic schists" all took place during the Early Maastrichtian and Campanian periods (77–70 m.y.; 32–30 magnetic anomaly). However we are of the opinion that this complex geodynamic evolution must have covered a longer time.

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