GEOLOGICAL EXCURSION TO SOUTHERN TIBET
A REPORT

The Chinese Academy of Geological Sciences organised an international Symposium on the 'Geology of Himalaya' from June 5 to 11, 1984 at Cjhengdu City, Sichuan Province, China. The Symposium was followed by two weeks geological excursion to Southern Tibet. This excursion was attended by some 40 foreign geoscientists from France, Great Britan, F. R. Germany, Italy, India, U.S.A. Japan and Canada and 20 geoscientists from China. The geological excursion was conducted in 24 jeeps along the road section following the route: Lahasa-Yangba Jain-Xigaze-Tingri-Nyalam-Zham-Xigaze Kangmar-Gyanze-Shigdze-Gonggar. A total of about 2500 km distance was covered in the excursion along best exposed geological cross-sections. Under a three year (1980-82) Joint Sino-French scientific programme, the Chinese and French geoscientists have carried out studies in Tibet. The geology along the excursion route was explained by both the Chinese and French teams.

The geology of the Southern Tibet as revealed from the excursion is summarised here. The four principal tectonic zones of Southern Tibet from south to north are the Higher Himalaya zone, Tethys Himalaya zone, Yarlung Zangbo Suture zone and Lhasa block. The characteristic features of each zone is described below along with a geological map of Southern Tibet.

Higher Himalaya Zone

The Higher Himalaya Zone consists of metamorphics and deformed granite gneiss together with small plutons and veins and pods of leucogranites. The crystalline rocks of the Higher Himalaya zone were observed along the section from the Friendship Bridge (the border post between Nepal and Tibet) to 50 km north towards the Yarlung Tsangpo zone. The main lithologies of the metamorphics are sillimanite, kyanite and staurolite schists and gneisses, migmatites, garnet gneiss, biotite augen gneiss and calc-sillicate rocks. Some of the 2-mica granites show development of mica fabric. Zircon ages of the orthogneiss range from 1250 to 1750 m.y. Rb-Sr and U-Pb whole-rock isochron ages of the granites range from 640-660 m.y. The K-Ar ages of micas range from 10-20 m.y. The uppermost part of the Higher Himalaya zone consists of phyllite, Quartzite, marble and biotite quartzite schist.

Tethys Himalaya Zone

The Tethys Himalaya zone consists of a Phanerozoic sequence that ranges from Cambrian to Eocene in age. It overlies metamorphics of the Higher Himalaya zone along a thrust. Two subzones are recognised in the Tethys Himalaya zone, the Southern Sub-Zone and Northern Sub-Zone.

Southern Sub-Zone: It is made up of Cambrian to Eocene sequence of largely sedimentaries which show shallow platform facies. The Carboniferous and Permian contain Gondwana facies sediments with glacial-diamictite which have yielded cold water fauna and glossopteries flora.

Northern Sub-Zone: The Palaeozoic strata in this zone is similar to that of the Northern Sub-Zone. The Triassic is composed of mudstone, siltstone and carbonate intercalated with intermediate acid volcanics. It shows sedimentary features similar

to a flysch sequence and also contains exotic blocks of carboniferous and Permian. The Triassic of the northern Sub-Zone resembles the Lamayuru Flysch of Ladakh.

Kangmar Dome and other Granite Bodies: Plutons of 2 mica-granite bodies of varying dimensions intrude into the Palaeozoic-Mesozoic sequence of the Tethys Himalaya zone. One of such granite bodies at Kangmar was studied. The Kangmar Dome consists of metamorphics forming a domal structure. The core of the dome is comprised of gneisses which have been dated at 485 + 6 m.y. (Rb/Sr), 226 m.y. (U/Pb) and 22-30 m.y. (K-Ar). The granite gneiss is coarse-grained and has 2 micas. The gneisses are overlain and surrounded by upper Palaeozoic metamorphosed sedimentaries. The metasedimentaries consist of chlorite mica, garnet and staurolite schists. The Kangmar dome is correlatable in structural setting, lithology and metamorphism with the Tso Morari Crystallines and Gurla Mandhata dome.

Yarlung Zangbo Suture Zone

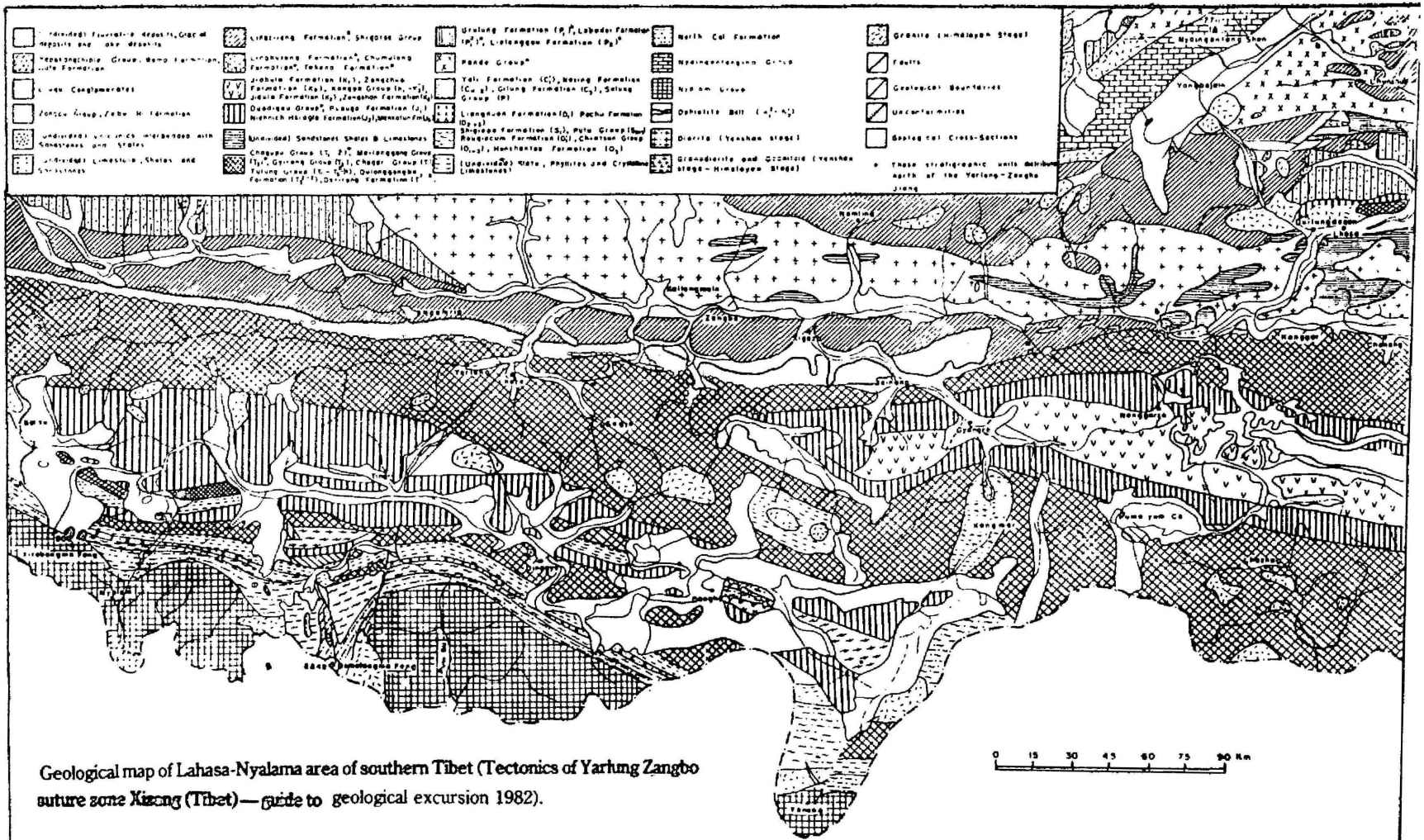
Yarlung Zangbo Suture zone is divided into five structural zones. These zones are: a) Flysh melange subduction belt, b) Yarlung Zangbo ophiolite belt, c) Flysch wedge of fore-arc basin, d) Epicontinental molasse and e) Gangdise Nyainqentanglha volcanic-plutonic arc.

Flysch melange subduction belt: This belt consists of sedimentary and tectonic melanges having matrix of shale, sandstone and marl containing Mesozoic (Triassic to Cretaceous) fauna. The exotic blocks in the melange vary in size from several metres to a few kilometres and of diverse origin and ages from early Permian to Cretaceous. The melange is overthrust to the south by the Mesozoic strata of the Tethys Himalaya zone.

Yarlung Zangbo ophiolite belt: The ophiolite sequence consists of ultramafic rocks, cumulates, sheet-like sills and dykes, mafic volcanic lava and abyssal-bathyal marine sedimentaries. The ultramafic rocks are predominantly serpentinised harzburgite, diopside harzburgite, lherzolite and minor dunite. The ultramafics are underlain by serpentinite melange.

The cummulates consist of dunite, peridotite and pyroxenite in the basal part. Its middle part is composed of layered olivine gabbro and its upper part consists of homogeneous gabbro. The sheet-like sills and cluster of dykes overlie the cummulate gabbro and are underlain by pillow lavas. The mafic volcanic lavas mainly consist of basalt, variolite, and spilite. They occur as either massive lavas or pillow lavas. Petrochemical analyses show that the mafic lavas belong to the ocean-ridge tholeiite series. The mafic volcanic lavas are overlain by a sedimentary sequence which consists of radiolarian cherts, siliceous shale, siltstone and arenaceous conglomerate. Yarlung Zangbo ophiolite belt is interpreted as representing the oceanic crust of the Tethys ocean of Jurassic-Cretaceous age.

Flysch Wedge of Fore-Arc Basin: A 10-30 km wide belt of flysch sedimentaries, occurs between the ophiolite belt to the south and Gangdise plutonic-volcanics belt and molasse to the north. The flysch sedimentaries, referred to as Shigaze group, consist of variegated shale intercalated with conglomerate and marlite lenses in the lower part, marlite, conglomerate, sandstone and limestone in the middle part and conglomerate, sandstone, siltstone and mudstone with bioclastic limestone in the upper part. The Shigaze group is of lower Cretaceous to Eocene age and is interpreted as representing deposits of a fore-arc basin.



Geological map of Lahasa-Nyalama area of southern Tibet (Tectonics of Yarlung Zangbo suture zone Xizang (Tibet)—guide to geological excursion 1982).

Epicontinental Molasse: The molasse unit consists of conglomerate, sandstone and shale intercalated with thin coal beds, volcanoclastics, volcanics and limestone lenses. It overlies unconformably the plutonic-volcanic rocks of the Gangdise-Nyainqentanglha belt. The molasse sedimentaries have yielded *Hipparion* and other fossils which have assigned a Miocene age to it.

Gangdise-Nyainqentanglha Magmatic Belt: The plutonic-volcanic rocks of this belt constitute a magmatic arc. The plutonics mainly consist of tonalite-granodiorite and granite which belong to mid-Cretaceous to mid-Eocene age. Geochemically the plutonics are calc-alkaline in composition, and in major, trace, rare earths and isotopic geochemistry they are similar to Cordilleran batholiths of the western coast of U.S.A. The plutonics were generated as a result of partial melting of oceanic slab during subduction of Tethyan oceanic crust under the Lhasa block.

The volcanics are intermediate to acidic in composition and consist predominantly of andesite, dacite and rhyolite. They range in age from upper Jurassic to lower Eocene.

Lhasa Block

The northern margin of the Lhasa block is delineated by the Bangong-Nujian ophiolite belt and its southern margin extends to the Yarlung Zangbo suture zone. Nyainqentanglha group consists of schists and gneisses intruded by 2-mica granites. It has been dated (U-Pb) at 1770 m.y., representing a Precambrian basement. The Precambrian metamorphics are overlain by the Palaeozoic sequence in western part of Tibet and Zheshan area, but in Lhasa area only Late Palaeozoic strata are exposed. The Late Palaeozoic rocks consist of diamictite and shale which have yielded *Stepanoviella* and *Lytovolasma* fauna. According to Chinese geologists these are cold water fauna of Gondwanian affinity, but French team working in Tibet do not subscribe to the Chinese view. The Mesozoic sequence is well developed in the Lhasa region. Triassic rocks mainly consist of limestone, volcaniclastics and intermediate-acid volcanics. The Jurassic strata are limestone and slate, whereas Cretaceous sequence is comprised of coal-bearing clastics, purple red clastics and intermediate-acid volcanics. The Mesozoic sequence is intruded along its southern margin by the plutonics of the Gangdise magmatic belt.

Correlation with Ladakh

The author has been working in the Indus Tsango Suture Zone in Ladakh for the last six years. The geological excursion to South Tibet has given him an opportunity to correlate the different tectonostratigraphic units of the suture zone of Ladakh with those from South Tibet.

Tethys Himalaya zone extends from Zanskar in the west through Spiti, Garhwal, Kumaun and Nepal to South Tibet. There is no marked facies variations laterally of the Phanerozoic sequence of the Tethys Himalaya. Tethys Himalaya zone sedimentaries are interpreted as representing passive continental margin sedimentation over the Indian plate. In Indian part of Himalayas, a gradational contact between Tethys Himalaya zone and underlying Central Crystallines of the Higher Himalaya zone has been described, but in South Tibet, the Chinese and French workers interpret a thrust contact between these two tectonic zones of Tethys and Higher Himalaya. Kangmar dome in South Tibet is similar in lithostratigraphy, metamorphism, structure and tectonic setting to the Tso Morari Crystallines in Ladakh.

The plutonic-volcanic rocks of the Gangdise magmatic arc of South Tibet represent eastern extension of the Ladakh magmatic arc. The ophiolitic melanges, ophiolites and associated trench sediments continue in a tectonically dismembered belt from Ladakh to South Tibet. The Xigaze group sedimentaries, which are interpreted as representing deposits of fore-arc basin, can be correlated in facies and structural setting with the Indus Formation. The Shyok suture zone of Ladakh probably coincides with the Bangong Nujian suture of North Tibet. This suture separates the Karakoram block from the Tibet block, but both the blocks have a similar stratigraphy.

Visit to Yangbajain Geothermal Field

The Yangbajain geothermal field is located 90 km north of Lhasa in a NE-SW trending fault-bound basin. The basin is 70 km long and a few km wide and lies at an altitude of 4300 to 4500 metres occupying a flat topography. The occurrence of hot springs, steam springs and hot water lakes are the direct evidence of a geothermal field. Hot water occurs in the Quaternary sand-gravel layer which is capped by clay. On drilling, hot water appears under artesian condition with well pressure of 3 kg/cm, well temperature of 160°C, well discharge of 48 l/sec. and with heat flow of gas-water mixture type. The gas is mainly composed of carbon dioxide and hydrogen sulphide. The hot water is mainly of sodium chloride type and the cold water of sodium or calcium bicarbonate type. The pH-value is higher than 7, showing alkalinity. The geothermal field of the Yangbajain has been developed to generate electricity. The experimental power plant is in operation and is producing 3000 kw of electricity, the projected target is estimated to generate 7000 kw of electricity from this field.

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