CHAPTER I

INTRODUCTION

The present work is based on the results of both the detailed field and laboratory investigations carried out by the writer on the 'Kargil Igneous Complex' occurring in the northwestern Himalaya. The 'Kargil Igneous Complex' forms a part of the 'Tethyan Zone' (Auden, 1937) or 'Trans-Himalayan Zone' (Pande, 1967), which falls within the northern 'Tethyan Geosyncline' (eugeosyncline) of Pande (1967). According to Wadia (1932), this area forms a part of Kashmir Nappe. However, Pande and Gupta (1972) do not agree with this nappe hypothesis.

A systematic study of both the Tethyan geosyncline and Himalayan basin (Pande, 1967; Fuchs, 1968) clearly indicates that the Himalayan mountain system, including the Trans-Himalaya, forms a part of Alpine-Himalayan orogenic belt. The Himalayan mountain system was uplifted in several phases during Upper Cretaceous-Tertiary time and forms the world's youngest and loftiest mountain chain.

The rocks of the Kargil area pose complex and intricate problems regarding their origin, lithostratigraphy, tectonics, structure, metamorphism, etc., yet the geological history of this area is fascinating and interesting. It has been now well established that the rocks of the Himalayan
zone and Trans-Himalayan zone show marked difference in lithology, stratigraphy, palaeontology, structure, metamorphism and tectonic (Pande, 1967; Pande and Saxena, 1968; Pande, 1975). Most startling feature of the Himalaya is that the rocks in the 'Himalayan Zone' (south of main crystalline zone) are mostly unfossiliferous and represent an inverted sequence of metamorphic rocks (Kanwar, 1966; Pande, 1967; Pande and Saxena, 1968; Wenk, 1968), while the rocks of the 'Trans-Himalayan Zone' are mostly fossiliferous from Cambrian to Tertiary times with a normal sequence of deposition. Pande (1967), Pande and Saxena (1968) and Fuchs (1968) explained this contrast by advocating the presence of two geosynclines, i.e., eugeosyncline or Tethys geosyncline in the north and miogeosyncline or Himalayan geosyncline in the south separated by a 'Central Barrier'.

The area under investigation (Fig. 1), being close to the border between India and occupied Jammu and Kashmir area by Pakistan, is of immense national strategic importance. As such, the author had to face a number of hurdles during the field work regarding the permission to survey the area, limitation of time to work in the area, restriction on photography and the use of topographical maps in the field. For the same reasons the contoured map with spot heights and triangulation points has been not appended in this thesis.
Aim of the Present Investigations:

From the geological research point of view, the 'Kargil Igneous Complex' is almost a virgin region. In 1969, an expedition of the Centre of Advanced Study in Geology was sent to Ladakh under the leadership of Prof. I.C. Pande. Members of this expedition took a rapid traverse through Kargil (Fig. 1) and adjoining areas. On the recommendation of the expedition, this area was selected for a detailed petrological study of the Kargil igneous complex. The present investigation has brought to light many interesting facts regarding these rocks which form the subject-matter of the present work.

Area:

The area investigated falls in Ladakh district of the Jammu and Kashmir State of India. It lies to the northeast of Srinagar (Kashmir) and adjoining to the international boundary between India and Pakistan. The region under study covers nearly 220 sq. km area around Kargil town.

Communication:

The settlement of Kargil (2676 m above MSL) lies on the left bank of Suru river, a tributary of Indus river (Fig. 2a). Kargil town (34° 34' N : 76° 05' E) is situated 125 km from Srinagar on Srinagar-Leh Highway, about 75 km northeast of Zoji-La (La means pass). The highway is open
FIG. 2a MAP SHOWING DRAINAGE PATTERN AROUND KARGIL

FIG. 2b GEOLOGICAL MAP OF LADAKH
(AFTER GEOLOGICAL SURVEY OF INDIA, 1963)
for transport during summer months (June-September) only. However, the communication is maintained through mule tracks and foot-paths for rest of the year.

Physiography:

a. Topography

The area under study is characterized by high mountains and a typical rugged topography comprising high ridges and steep escarpments (Pl. 1a). The valleys are U-shaped, deep and narrow. There is a maximum relief of an average 2,500 m. The mountain slopes are steep, ranging between 30° and 45° (Pl. 1b). Near the escarpments, which are common, the slopes are extremely steep (more than 45°). Frost action and gravity transfer are the main determinant factors of the nature of slopes.

The most important physiographic feature of the area is Somnu ridge which runs northeast-southwest between Shamsha and Somnu villages (Fig. 2a). Fine radiating spurs originated from this ridge form steep slopes on the eastern side of the ridge. This ridge forms the watershed between Suru and Dras rivers. Only small parts of other ridges are present in the mapped area.

In conclusion, the rugged topography and U-shaped valleys are the characteristics of this area.
b. Drainage

The area forms a part of drainage basin of main Indus river. It is drained by two major rivers, namely, Dras and Suru (Fig. 2a). These rivers are fed by small valley glaciers and have large catchment areas. The small streams join the major rivers nearly at right angles forming a radial type of drainage pattern throughout the area. The river Siago along with its tributary Dras and other smaller streams drains the southwestern, western, northwestern and northern parts of the area. The northeastern, eastern, southeastern and southern parts of the area are drained by Suru river and its main tributary Wakha including other smaller streams.

The Suru river covering a distance of about 4 km to the north of Kargil drains into Siago river which is called, in this part, as Dras river. Then it flows in a northeast direction and finally drains into the Indus river - outside the map area (Fig. 1).

c. Climate

The climate of Kargil area is cold and arid. The area lies in the northern side of the Higher Himalaya. So its climate is totally different from the other parts of Himalaya. As such, the climate can be divided into two main seasons, that is, winter - from October to May - and summer - from June to September. The temperature mostly remains
below freezing point during winter and at times the mercury falls as low as -28°C. The area experiences a heavy snowfall during this season and the rainfall is almost negligible. Snow-biting or snow-burns are common in this season. Summer is pleasant although, at times, the days are hot yet nights remain quite cool. Snowfall during summer is restricted to higher altitudes.

The average rainfall in the area is 13 cm and it is confined to the summer season only. As the rain is very scanty, the main source of water is snow which feeds springs and streams. According to the latest report of Jammu and Kashmir Government, the climate of the Ladakh region is changing slowly and there is a noticeable increase in the rainfall.

Fauna and Flora:

Due to extreme cold climate and lack of vegetation, the wildlife is represented mainly by: wolf (Canis lupus), wild goat (Capra lirana), Pex (Vulpes), Kastura (Moschus moschiferus) while horse, yak, sheep, goats and dogs are the common domestic animals.

Absence of good soil cover and the cold climate are the causes of scanty vegetation which is represented by shrubs and bushes in the higher altitude and Populous (Populous nigra), Apricot (Prunus domestica) and Apples
(Malus malus) in the river valleys or near the natural water sources are common.

**Lines of Investigation:**

The field work was carried out in four field seasons during 1970-73. An area of about 220 sq. km was mapped around Kargil by outcrop and traverse mapping methods. A reconnaissance survey was done in the beginning to ascertain the nature and variation of the rock types and finally a geological map was prepared on four inch to a mile scale map enlarged from 1/4" to a mile toposheets Nos. 52 B/2 and 43 N/14. The field and petrographic relations have been used to determine the possible sequence of emplacement of igneous bodies.

During the field investigations, nearly 500 oriented and unoriented rock specimens were collected. Their sections were studied under microscope. The mineral assemblages of rocks have been used to classify the Kargil igneous rocks. On the basis of texture and mutual relationship of the constituent minerals, a mineral paragenesis has been established.

Chemical analyses of representative samples were carried out by the rapid methods of Shapiro and Brannock (1962). SiO₂, Al₂O₃, TiO₂, P₂O₅ and MnO were determined by Hilger and Watts Spectrophotometer; Na₂O and K₂O were
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determined with the help of EEL Flame-photometer. Fe₂O₃, FeO, MgO and CaO were determined both by spectrophotometer and titration methods.

Various important optical properties of minerals were studied using a Leitz Four-Axis Universal Stage. Plagioclase study was done according to the methods of Reinhard (described by Naidu, 1964).

The results of the investigation are presented in the following chapters of this thesis. Location of the area, approaching route, its physiography and climate have been described in the preceding pages of this introductory chapter. Regional geology, previous work, geological setting, age and structure of the area have been discussed in chapter II. Petrography of the various rock types based on their megascopic and microscopic characters has been elaborated in chapter III. A detailed description of the physical and optical properties of the constituent minerals has been given in chapter IV. Chemistry and other related geochemical aspects pertinent to the classification and genesis of the Kargil igneous complex form the subject-matter of chapter V. Genesis of the rocks has been discussed in chapter VI in the light of field, petrographic and geochemical evidences. Results of the investigations have briefly been summarised in chapter VII.

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