CHAPTER 3

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Lithology

The central part of the province, surrounding the Rengali reservoir, Odisha exposes variety of rocks showing contrasting grades of metamorphism. Detailed lithological mapping of the study area reveals a complex litho-association that includes high-grade granulites and gneisses, medium-grade intrusives as well as low-grade supracrustal rocks (Fig. 3.1). Based on the disposition of rocks with broadly uniform metamorphic characters, the area can be subdivided into three distinct WNW-ESE trending elongated zones described hereafter. These zones are characterized by distinct lithology, deformational histories and contrasting grade of metamorphism. Moreover, these zones or belts are separated by a number of regional-scale faults or shear zones.

3.1 High-grade rocks of the gneissic basement

The basement is essentially composed of gneissic rocks of both amphibolite-and granulite-facies mineral assemblages along with several basic and felsic intrusives. Granulite-facies assemblages are represented by charnockite gneiss and mafic granulite whereas the majority part of the basement is occupied by migmatitic hornblende gneiss and hornblende-absent felsic gneisses. This rock is highly foliated in nature, locally occurring as a part of the basement rock on which the flanking supracrustal sequences rest. The main charnockite body crops out as an E-W trending ridge within gneissic rocks and has a strike length of about 15-20 km forming the shoulder of the Rengali dam (Fig. 3.1). Charnockite also occurs as patches or enclaves of smaller dimension sporadically within the gneissic basement (Fig. 3.2). The boundary between such charnockite gneiss and the host gneiss is diffused in nature. Foliation in charnockite gneiss is marked by alternate thin layers of orthopyroxene and thicker layers of quartz and feldspar. Garnet is sporadically present in some charnockite occurences. A prominent down-dip stretching lineation of quartz is present on the foliation surface (Fig. 3.3). In the Brahmani river section, charnockite gneiss locally shows stretching of feldspar porphyroclasts in a very fine grained mylonitic dark-coloured matrix (Fig. 3.4). This possibly resulted from shearing along the foliation plane. A pegmatite vein is found to have intruded parallel to the foliation plane of the charnockite gneiss. This pegmatite also suffered a later deformation, evident from the boudins or pinch-and-swell structure of the gneissic foliation (Fig. 3.5). The major part of the basement is constituted of migmatitic hornblende gneiss and felsic granitoid gneiss. Gneissic layers in the migmatitic hornblende gneiss show tight isoclinal folding (Fig. 3.6). Felsic granitoid gneiss forms the major part of the basement and it often appears leucocratic to pink in colour. Thin layers of leucogranite is also present within the migmatitic hornblende gneiss along the gneissic foliation (Fig. 3.7). Felsic gneiss is essentially composed of quartz and alkali feldspar, with subordinate amount of plagioclase, biotite and garnet. The dominant structural fabric, especially the gneissic foliation appears to show unchanged characteristics when passing from the host gneiss to the charnockite patch.

Mafic granulite occurs as enclaves within the charnockite gneiss. Within the Brahmani river section, mafic granulite occurs as boudin within the charnockitic gneiss (Fig.3.8). The rock is highly deformed containing a pervasive gneissic foliation. Here thin gneissic foliation gives a banded appearance (Fig.3.9). On fresh road cut sections, coarse pyroxene and garnet grains can be identified. Exposures in low grounds are, however, extremely decomposed in nature as hornblende grains appear possibly replacing the pyroxene grains. Apart from the granulite enclaves, boudinaged layers of leucocratic calc-silicate granofels also occur within the charnockitic gneiss.

Amphibolite occurs as enclave within the felsic gneisses. In most cases, the rock appears to be homogeneous with dark hornblende and occasional garnet (Fig. 3.10). Some rocks are garnet-free but show prominent gneissic banding. In the latter, gneissic banding is defined by alternate hornblende-rich and plagioclase-rich bands that run parallel to the foliation. Some of the detached plagioclase-rich lenses show stretching due to the prominent shearing (Fig. 3.11). Stretched en-echelon amphibolite layers with leucosome envelope are found within darker amphibole-rich rocks. Plagioclase-rich leucocratic layers sometimes show ptygmatic folding (Fig. 3.12).

Metagabbro enclaves are also observed within the felsic gneiss at the central part of this belt. A fine-grained N-S tending dolerite dyke (Fig. 3.13) intrudes the host charnockite gneiss and felsic gneiss near the Rengali dam site, which later gets displaced by the NW-SE trending shearing and shear-parallel pegmatitic vein (Fig. 3.14). A very thin (< 1 cm thick) chilled margin is present between the dyke and the host charnockite gneiss (Fig. 3.15).

On the westernmost corner of the study area, two NE-SW trending fault system occur and the intermediate region is termed as Riamol Shear Zone. In this zone, the high-grade rocks show an amphibolite facies assemblage. On the eastern corner, these high-grade rocks got deformed by a regional scale NNW-SSE trending shear zone.

3.2 Low-grade supracrustals rocks

3.2.1 Low-grade supracrustal rocks lying south of the gneissic basement

Low grade supracrustals rocks occur along a WNW-ESE trending longitudinal belt at the southern margin of Rengali Province (Fig. 3.1). The Kerajang Fault Zone marks the boundary between the Rengali Province and southern lying Eastern Ghats Belt and Gondwana sediments. The NW-SE trending Tikra nulla possibly follows the Kerajang Fault Zone as the southern bank of the river exposes the flat-lying Gondwana sandstone, while the northern bank exposes deformed quartzite. The area situated on northern bank of the Tikra nulla is composed of quartzite with thin layers of mica schist, both showing greenschist facies metamorphism. Quartzite shows colour banding which is considered as the trace of bedding

(S_0). The bedding plane of quartzite shows complex fold interference in places exposed within the Tikra river bank (Fig. 3.16). Quartzite at the further south, shows dominantly brecciated character (Fig. 3.17) with presence of numerous quartz veins, indicating a brittle phase of deformation. A pegmatite body is found to have intruded into the quartzite unit (Fig. 3.18). Central part of this belt is composed of alternate bands of quartzite, mica schist and calc-silicate schist, all showing greenschist facies metamorphism. The occurrence of the calc-silicate schist is noted, only within the Tikra nullah section. In this rock, compositional layering (S_0) is marked by alternate calcite-rich (leucocratic) and tremolite-rich (light green color) layers. Schistosity is shown by the orientation of tremolite grains. Both the compositional layering and the schistosity show complex fold interference on outcrop-scale (Fig. 3.19). In the associated quartzite, trace of bedding plane (S_0) can be identified from the color banding. The alternate dark and light brown layers indicate variable amount of ferruginous material. Foliation (S_1) in this unit runs parallel to the banding (S_0) mostly along the limbs of large folds. This foliation also shows outcrop-scale folding (Fig. 3.20) with the development of down-dip quartz stretching lineation on axial plane. Goethite-bearing veins and layers (about 10 cm thick) occur parallel to the bedding plane (Fig. 3.21). Mica schist is the third variety of rock exposed in this belt. It is composed dominantly of muscovite and quartz with small percentages of biotite. The rock is highly schistose in nature and friable in character (Fig. 3.22). Apart from this, relics of the basement gneiss are also present locally. An isolated body of leucogranite is exposed within the quartzite-mica schist units in the Tikra nulla section near the Budhapal area (Fig. 3.23). Amphibolite facies muscovite-sillimanite-fibrolite schist, with high concentration of magnetite occurs at the northern part of the supracrustal sequence, adjacent to the high grade rocks. Though the entire sequence is composed of low-grade greenschist facies assemblages, presence of this higher grade rock suggest a shearing related increase in temperature that ultimately resulted in metamorphism and increase in grade of the assemblage.

3.2.2 Low-grade supracrustal rocks lying north of the gneissic basement

This supracrustal sequence is bounded by gneissic basement in the south and a regional scale Barkot Shear Zone in the north (Fig. 3.1). Barkot Shear Zone marks the northern boundary of the Rengali Province with the Singhbhum Craton. The supracrustal belt is essentially composed of low-grade rocks, mainly Banded Iron Formation (BIF), metachert, metaconglomerate, metagreywacke, mica schist, metabasic (chlorite-actinolite schist) and quartzite. All these rocks overlie the felsic gneiss basement which is exposed at the Chilanti nullah section (Fig. 3.24). Although metamorphosed, primary sedimentary structures could be identified within the metasedimentary rocks in this belt. Quartzite in many places locally show cross laminations (Fig. 3.25) and graded bedding (Fig. 3.26). At some places, the quartzite appears to be gritty with clasts of quartz showing asymmetric tails in sections. These asymmetric clasts show dextral sense of shear. Metagreywacke is dark coloured and show thin planar bedding (Fig. 3.27). Both bedding (S_0) and cleavage (S_1) could be identified in the rock. On freshly exposed surface, recrystallized clastic fabric of the rock could be identified. This rock is closely associated to metaconglomerate. Fragments of basement gneiss have been identified within the metaconglomerate (Fig. 3.28). A heterolithic unit also occurs within this sequence. Alternate sandy and shaly beds within the heterolithic unit shows sedimentary deformation structures like flame structure, dish structure etc. (Fig. 3.29). The quartzite and metagreywacke units at the northwestern part of the study area near Kansar are intimately associated with metabasic rocks. These metabasic rocks are very fine-grained, containing very fine grains of chlorite and actinolite. The mineral assemblage suggests a greenschist facies metamorphic condition.

The basement gneissic rock is exposed sporadically within this belt. The basement gneiss unit is composed of quartzofeldspathic and migmatitic gneisses with intrusive pegmatites and metabasic dykes. These rocks show mostly amphibolite facies assemblage of quartz-feldspar-garnet-hornblende with gneissic layering defined by alternate mafic- and leucocratic layers. At the northwestern part, near the Badarama Ghat road, charnockite gneiss occurs as the main basement component. Metadolerite intrusives are medium-grained and massive in appearance. Small isolated outcrops of amphibolite also occur within the gneissic basement. Near the Barkot Shear Zone, the quartzite-conglomerate units of this belt as well as northerly lying Singhbhum Craton change to quartzite mylonites and foliated conglomerates (Fig. 3.30).

Another fault zone of moderate width occurs at the eastern margin of the study area. This zone is mainly composed of low-grade basic volcanics and supracrustal rocks of the southerly lying supracrustal belt (Fig. 3.31).

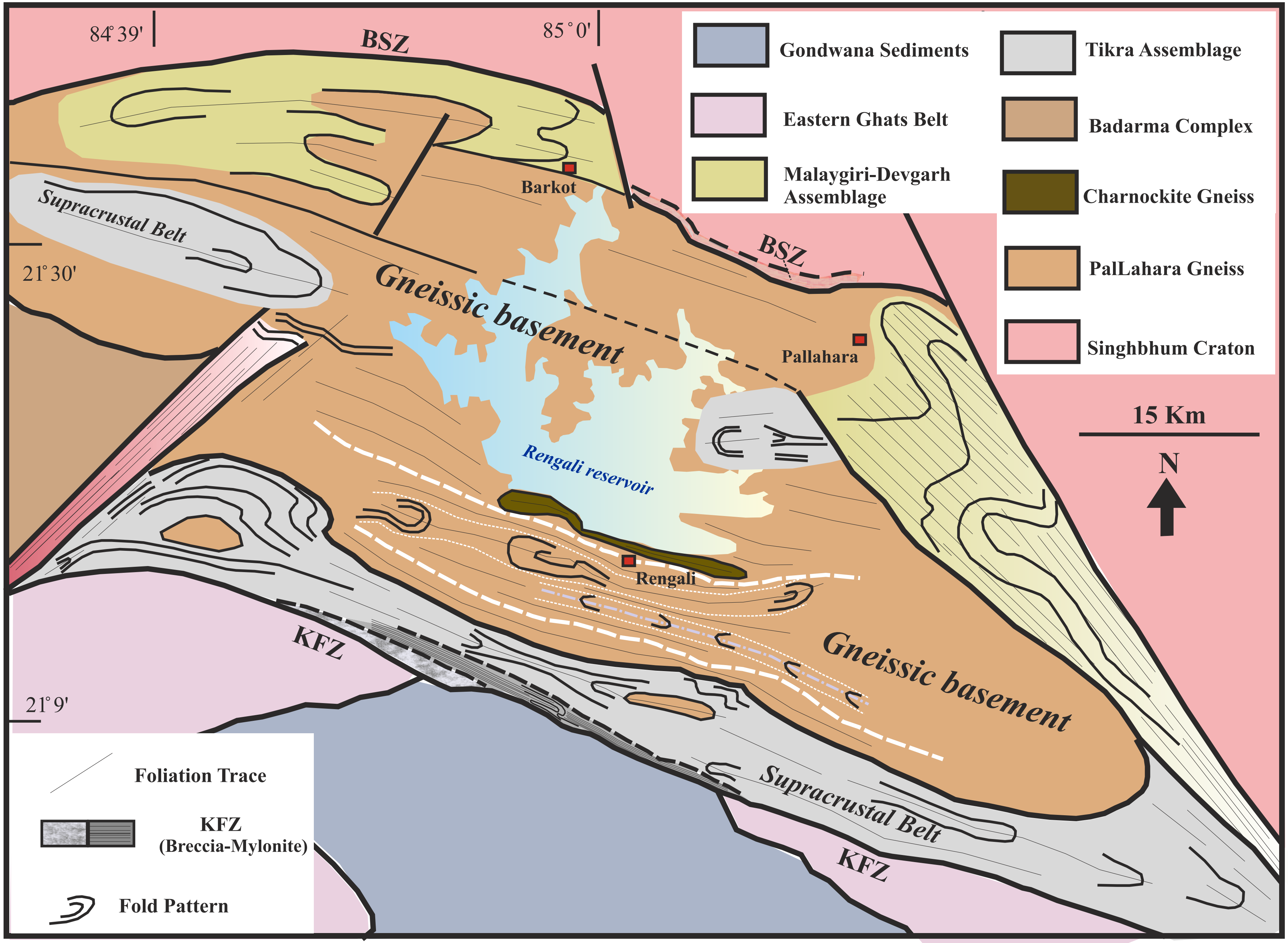
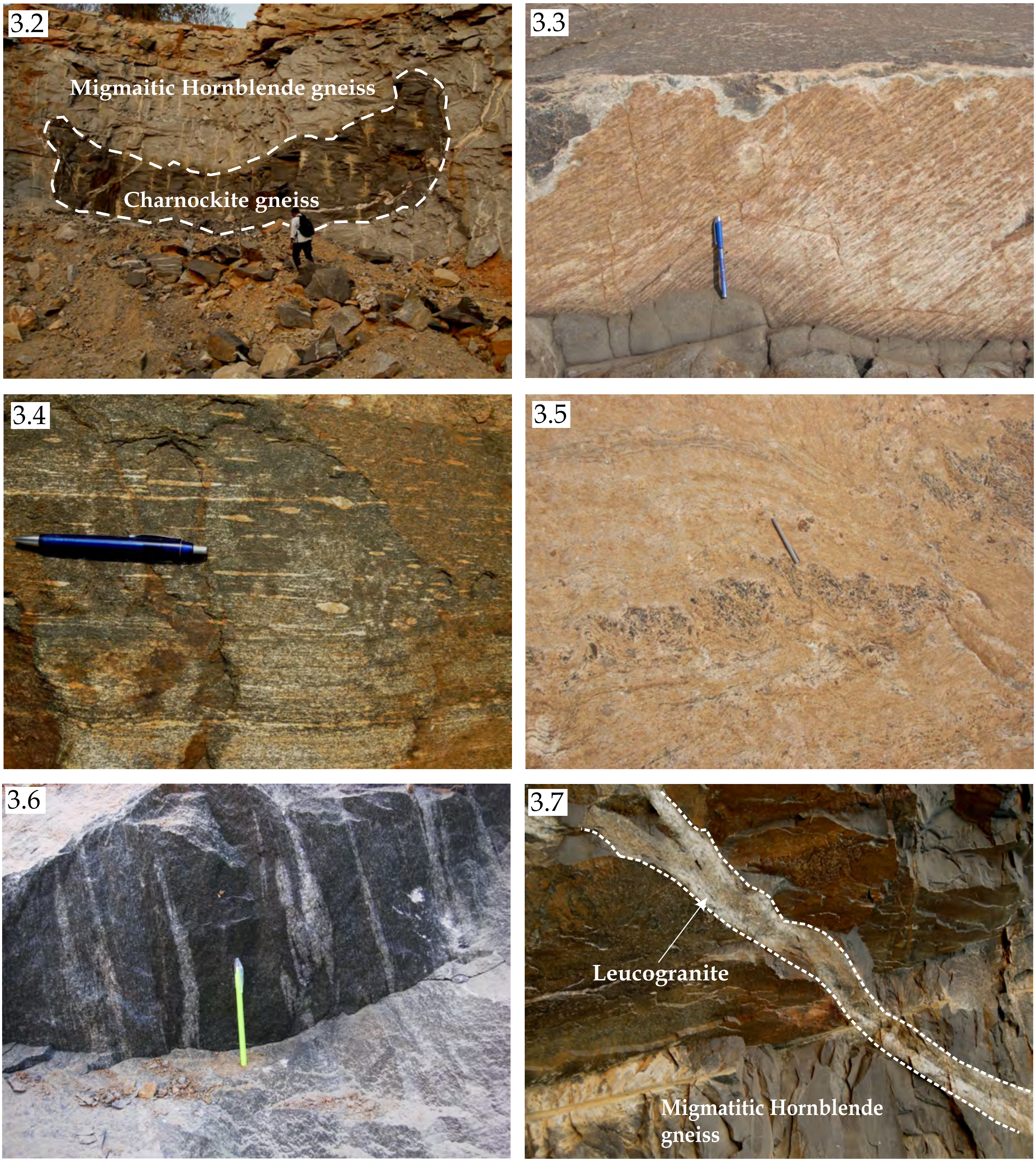
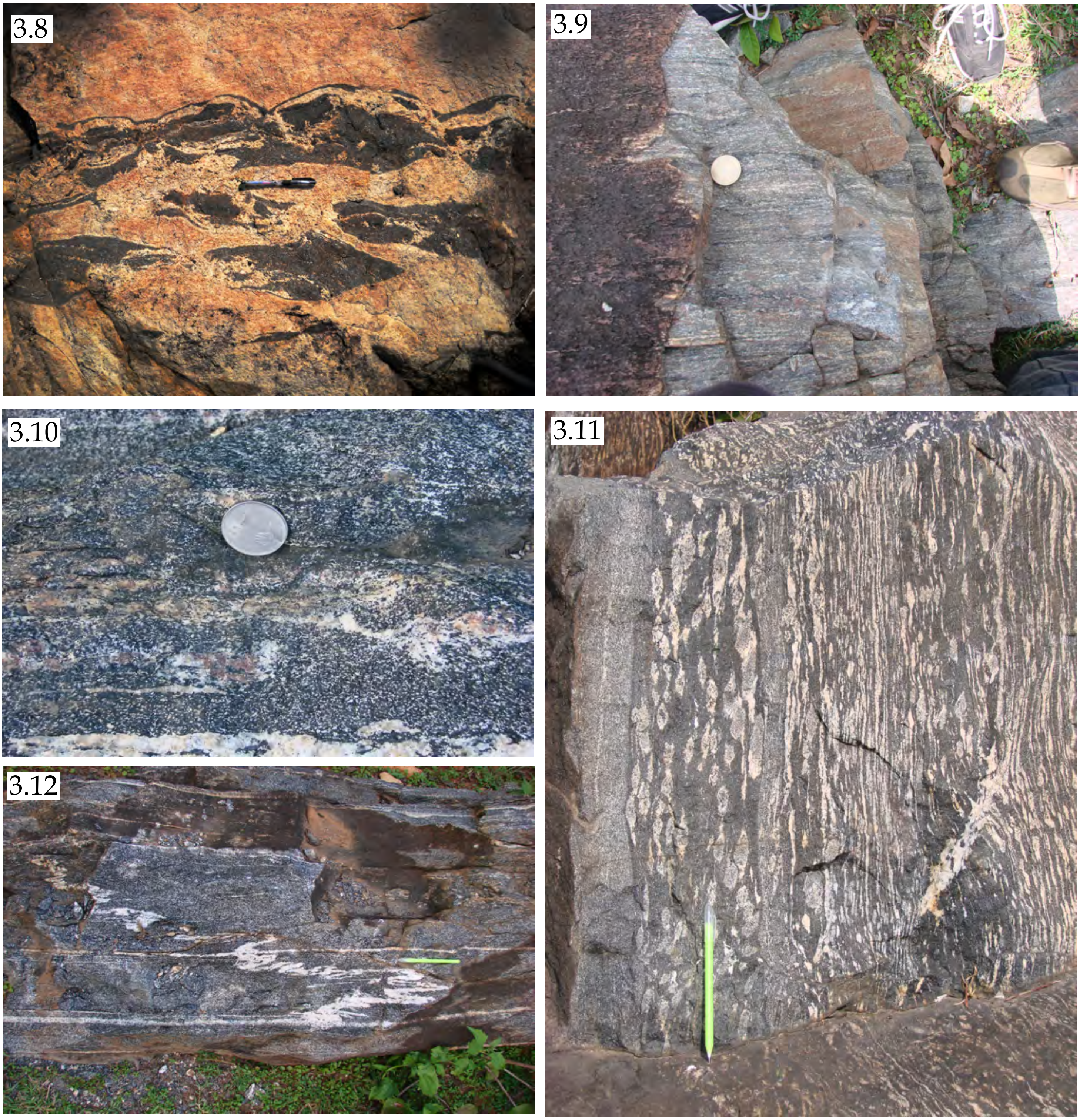


Fig. 3.1: Detailed map of central part of the Rengali Province, depicting the main lithological units from the study area around Rengali reservoir.

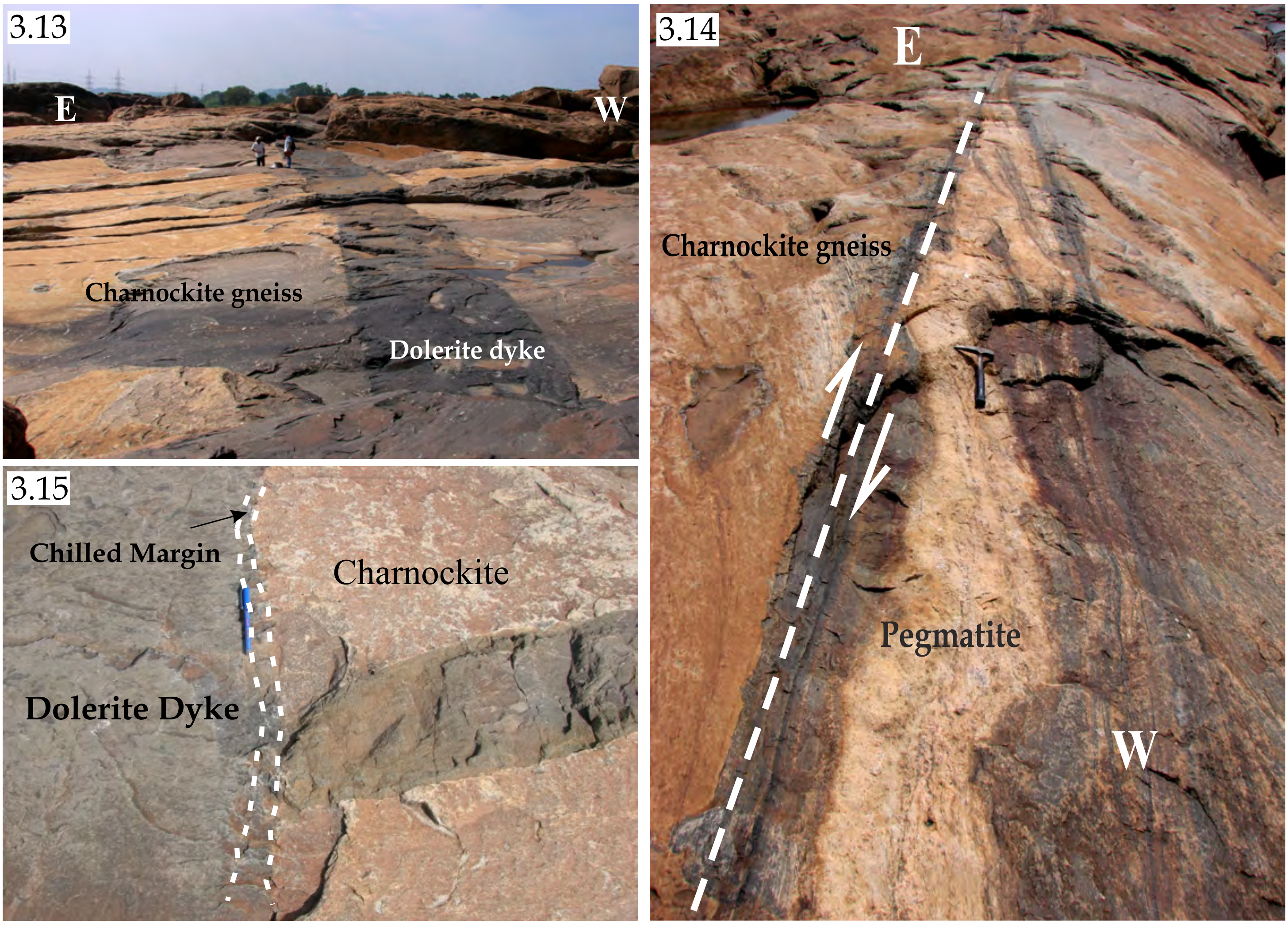


High grade rocks of the gneissic basement

Field photographs of Fig.(3.2) Charnockite occuring as patches within the host migmatitic hornblende gneiss. (3.3) Down-dip mineral lineation of foliation surface. (3.4) Stretching of feldspar porphyroclasts in charnockite. (3.5) Pinch-and-swell structure of pegmatite within host charnockite. (3.6) Tight isoclinal intrafolial fold in migmatitic hornblende gneiss. (3.7) Intrusive leucogranite within host gneiss.

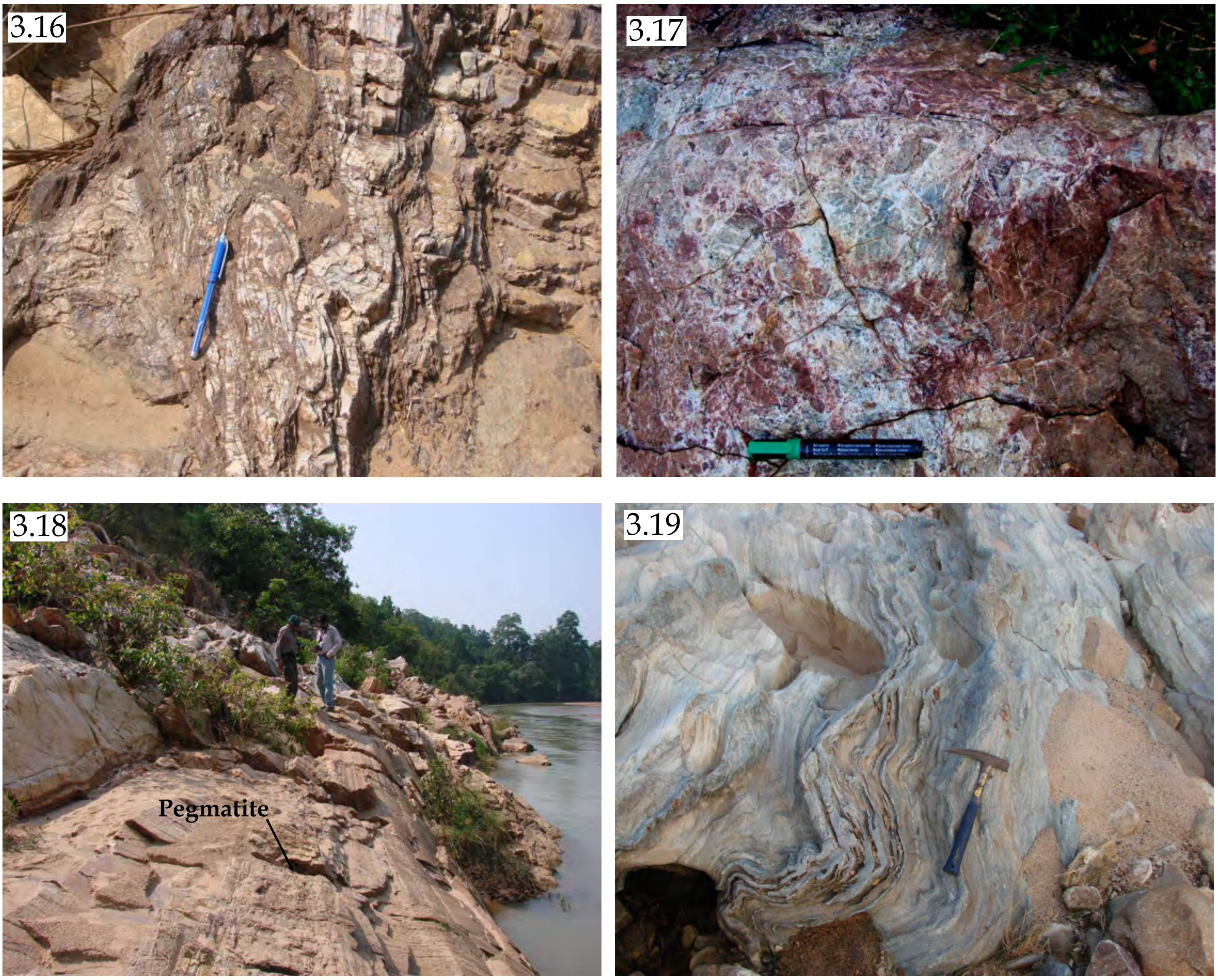


High grade rocks of gneissic basement
Field photographs of Fig.(3.8) Mafic granulite boudins within charnockite. (3.9) Gneissic foliation in mafic granulite on outcrop-scale. (3.10) Amphibolite with dark homogeneous hornblende layer with occasional presence of garnet. (3.11) Stretching and detachment of plagioclase-rich layers in amphibolite (3.12) Plagioclase-rich leucocratic layers within amphibolite showing ptygmatic folds.

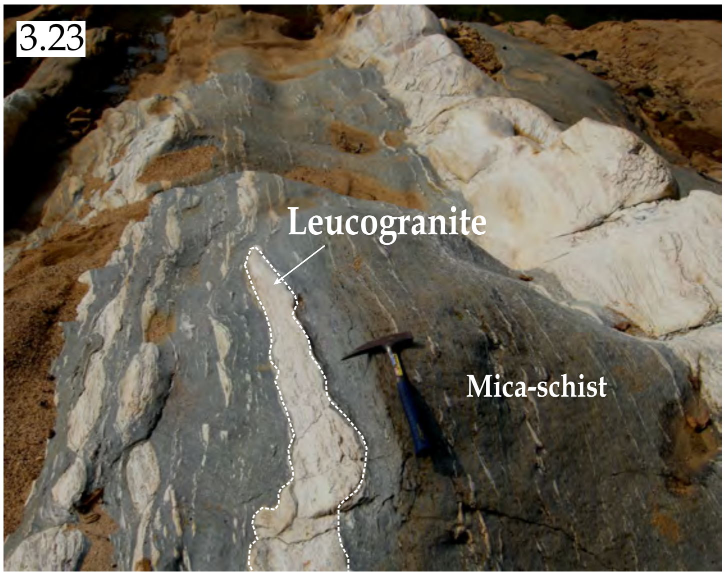


High grade rocks of gneissic basement

Field photographs of Fig.(3.13) N-S trending regional-scale dolerite dyke (3.14) NW-SE trending shear plane and shear parallel pegmatite. (3.15) Chilled margin between the dyke and the host charnockite gneiss.

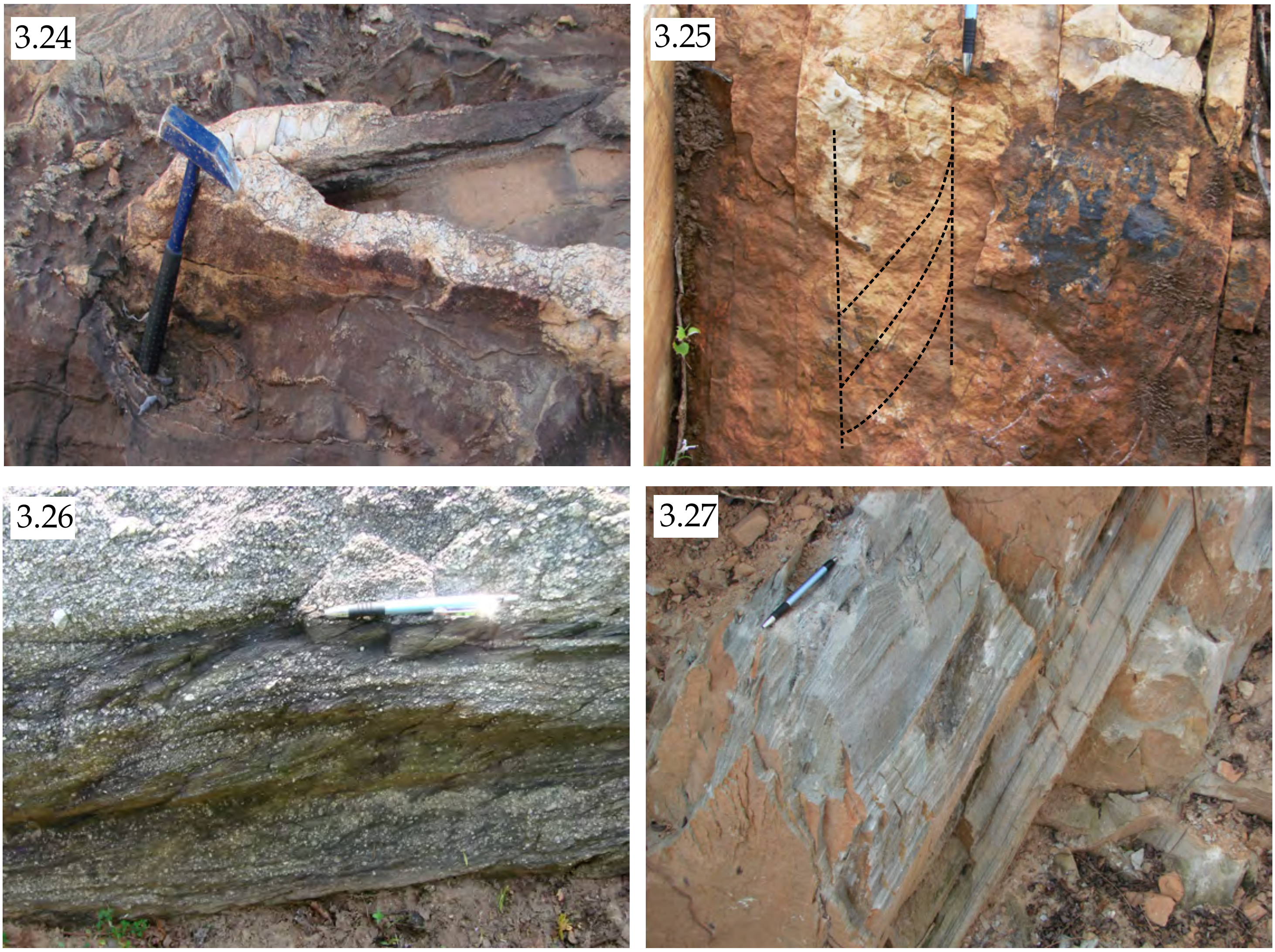


Low grade supracrustal rocks south of the gneissic basement
Field photographs of Fig.(3.16) Complex fold interference pattern within quartzite. (3.17) Brecciated quartzite. (3.18) Intrusion of pegmatite body within the host quartzite. (3.19) Outcrop-scale complex fold interference pattern within calc-silicate schist of the southerly lying supracrustal sequence.



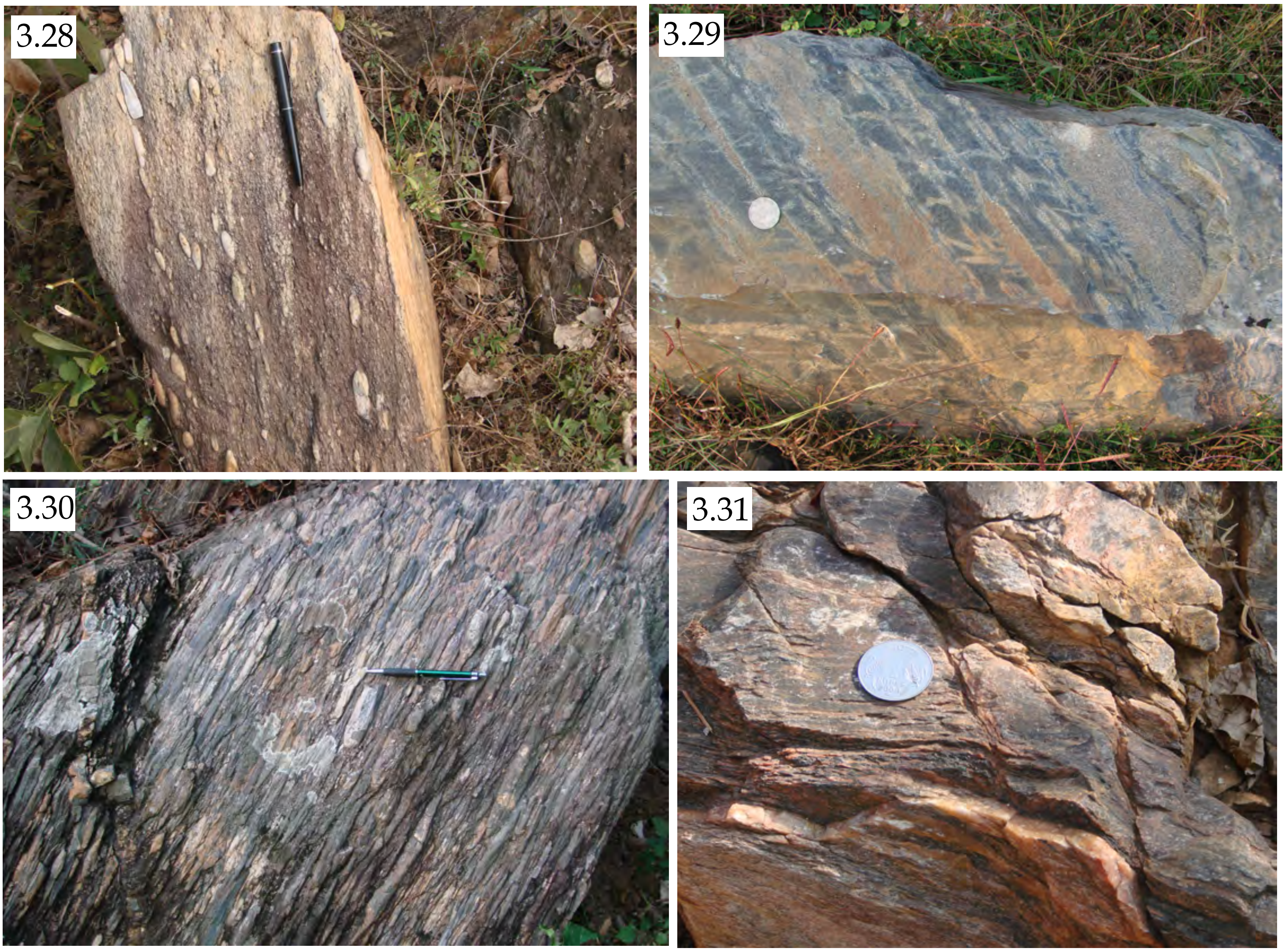
Low grade supracrustal rocks south of the gneissic basement

Field photographs depicting Fig. (3.20) Folding of compositional banding and banding parallel foliation (S_1) in quartzite. (3.21) Goethite bearing layer parallel to the quartzite bedding. (3.22)Mica-schist showing its highly schistose character. (3.23) High grade leucogranite exposed within low grade supracrustal in an exposure within Tikra nulla.



Low grade supracrustal rocks north of the gneissic basement

Field photograph depicting Fig. (3.24) Basement felsic gneiss exposed within northern supracrustal sequence, showing folding. (3.25) Cross-lamination within quartzite. (3.26) Graded bedding in metagrewacke (3.27) Thin planar bedding within metagrewacke.



Low grade supracrustal rocks north of the gneissic basement
Field photographs of the Fig. (3.28) Metaconglomerate containing granite pebbles. (3.29) Soft sedimentary deformation structure within the heterolithic rock unit. (3.30) Development of foliation and elongation of clasts in conglomerate showing deformation within the Barkot Shear Zone. (3.31) Quartzite from the Malaygiri assemblage deformed within Akul Fault Zone.