B7 Tater-Du

[SW 440 230]

Highlights

At this excellent contact with the Land's End Granite, the progressive change from basaltic lavas to metamorphic and metasomatic hornfelses of varied mineralogy and chemistry, is particularly well seen.

Introduction

The dark, steep cliffs and sloping rock platforms of Tater-du at the southern tip of the Penwith Peninsula [SW 440 230] are a small erosional relict of aureole rocks adjacent to the Land's End Granite (Figure 4.21). The area from Tol Toft in the east to Zawn Gamper in the west, including the crags and quarry just inland, are perched on the southerly dipping contact zone of the surrounding megacrystic granite. The eastern end is represented by a faulted gully, while to the west an excellent contact between the aureole rocks and the marginal facies of the granite is exposed in the wall of Zawn Gamper. Apart from a petrographic description of the hornfelses (with some chemical data), little research has been done on this aureole segment (Floyd, 1965, 1975), although it represents a microcosm of the contact alteration of basic volcanics in the hornblende hornfels facies.

Description

Directly above the granite contact at Zawn Gamper, is a thin, variably retrogressed cordierite–biotite petite that can be traced intermittently along the lower rock ledges below the main cliffs of Tater-du. At the granite contact it is tourmalinized and shows the development of late, randomly orientated, muscovite flakes. The rest of the site is mainly composed of massive, well-banded, dark hornblende-bearing hornfelses, with minor horizons of unusual Mg-rich and Ca-rich hornfelses. These are best developed below the main cliffs near one of the metasedimentary lenses; this has a thin, partly developed, cummingtonite-bearing adinolized contact zone with the adjacent meta-volcanics.

The basic volcanics here were intensely sheared prior to contact metamorphism, so that there is little direct evidence as to their original nature. The presence of adinolized sediment implies that some of the volcanics were probably intrusive sheets, as adinole development is only seen adjacent to dolerite sills in other less-tectonized parts of the aureole. However, the majority of the Tater-du basic hornfelses exhibit small diopside- rich lenses and spots, now drawn out parallel to the foliation, which may have originally been infilled vesicles in a sequence of lavas. The mimetic growth of contact-metamorphic minerals accentuates the early shear foliation and locally this produces a banded rock composed of various, nearly monomineralic, layers – typically amphibole, biotite or diopside (Figure 4.22). Some of the more lenticular structured hornfelses show weather-resistant amphibole phacoids surrounded by deeply eroded, pale-purple, biotite rims. The hard phacoids might have originally represented the more crystalline cores of metamorphosed pillow lavas; the altered glassy rims (altered to chlorite) were subsequently replaced by biotite during contact metasomatism.

The normal basic hornfelses are mainly composed of the ilmenite–plagioclase–hornblende assemblage with variable replacement of the amphibole by biotite, representing the introduction of K from the granite. Some bands feature calciferous zones with the development of diopside and labradorite in lenses and the replacement of primary ilmenite by sphene in the matrix. This feature can be seen throughout the site, but is well displayed in the small quarry behind the lighthouse, where the calciferous lenses may represent metamorphosed vesicle infillings. The normal assemblages were largely developed by the isochemical metamorphism of basic volcanics under hornblende hornfels facies conditions.

In addition to these dominant assemblages, unusual hornfelses are well developed on the rock platforms under the main cliffs and towards Tater-du Point. Two groups may be observed: Mg-rich hornfelses and Ca-rich hornfelses. The lower portion of the cliffs consists of lenticular, variably biotitized hornblende hornfelses with large white lenses of diopside.

Below and interbedded with this horizon is a conspicuous highly foliated biotite–cummingtonite hornfels with black lenses of cummingtonite-rich rock weathering less than the biotitic matrix. Traced towards Tater-du Point, these rocks become more massive, lustrous black in colour, and are represented by cordierite–anthophyllite hornfelses. This small section demonstrates the lateral gradation from normal hornfelses through to cummingtonite-bearing and finally anthophyllite-bearing types. On the same rock platforms, but below the pelitic wedges, is a small outcrop of the Ca-rich hornfels or skarn. This highly weathered mass replaces both the hornblende hornfelses below and the adjacent pelites, such that fragments of adinole are found within the skarn deposit. The skarn is dominated by grossularite and diopside, although sphene, zoisite, clinozoisite, axinite and calcite are also present. In the contact zone with the basic hornfelses, diopside and garnet replace hornblende and plagioclase, and sphene nucleates on ilmenite.

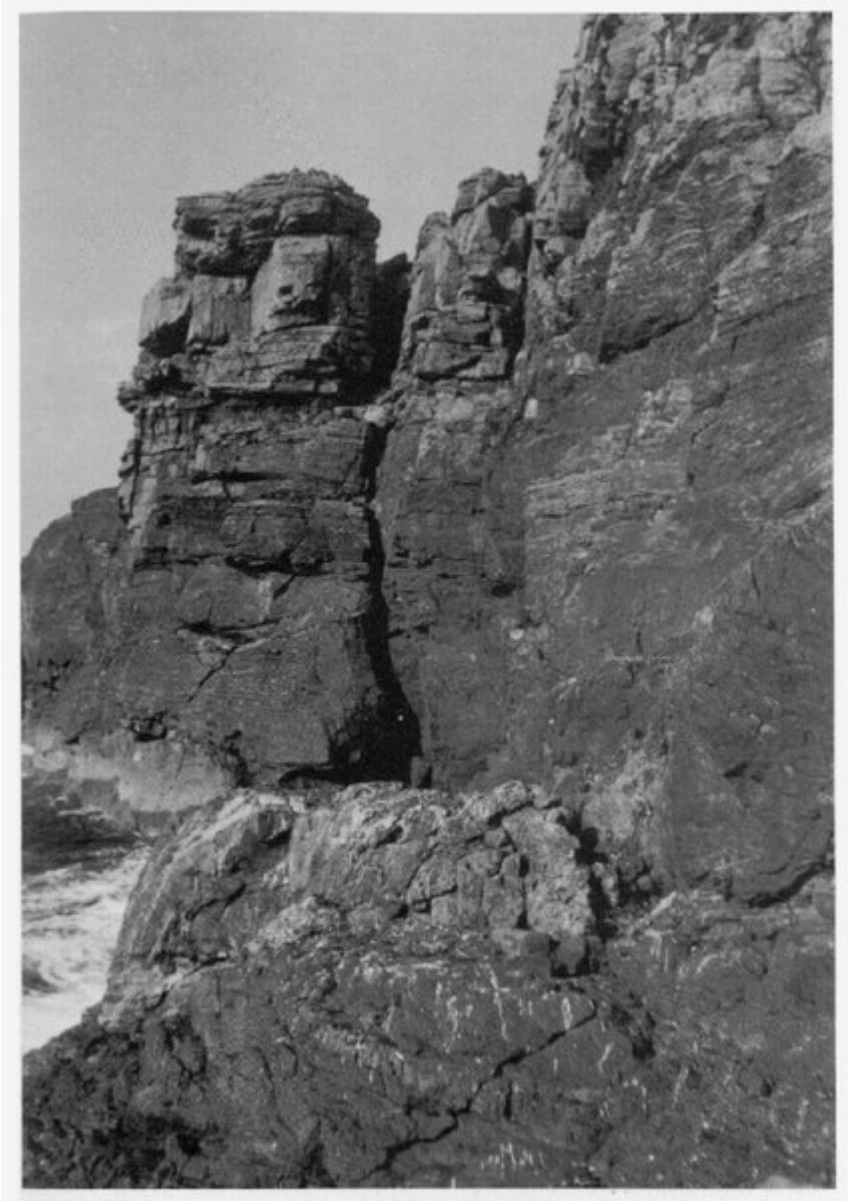
Interpretation

The significance of this locality concerns the paragenesis and range of hornfelses produced by the contact metamorphism and metasomatism of originally basaltic volcanics. Not only have normal hornblende-bearing contact hornfelses been produced, but also two groups of unusual hornfelses that are genetically complementary and chemically linked. In particular, they demonstrate both the importance of original composition and the effects of local metasomatism on the final metamorphic assemblage. Their development is the same as similar exotic hornfelses from Botallack (discussed above), with contact-metamorphic effects acting on variably degraded basaltic volcanics, together with localized element migration under hydrothermal conditions. The lateral gradation of hornblende hornfelses into both the Mg-rich and Ca-rich hornfelses is important field evidence for the origin of the unusual hornfelses from the initial basic assemblages. However, mineralogical relationships and replacements suggest two different, but complementary, processes. The normal hornfelses represent basic volcanics that have been only slightly altered by previous regional metamorphism, whereas the Mg-rich hornfelses were developed isochemically from highly degraded, carbonate-poor but chloritic metabasics, as direct mineral replacements are rare. On the other hand, the skarn deposits show ample evidence for replacement of the normal hornfels assemblage, as well as progressive internal replacement of previous calc-silicates. After the initial assemblage of sphene–diopside–grossularite was produced under hornblende–hornfels–facies conditions, a retrogressive phase started with the replacement of garnet by clinozoisite and zoned axinite, and finally all minerals by calcite (Floyd, 1965). As at Botallack, the involvement of granite-derived fluids is indicated here by the presence of B-bearing axinite during the later phases of skarn development.

Conclusions

Tater-du shows rocks of late Devonian age (around 370 million years old) that have been so severely affected by later geological events that there is little direct evidence of their original composition, although they are believed originally to have been basalt lava flows. They have been altered to different hornfelses, the product of mineralogical and chemical alteration largely induced by contact with the emplacement of the adjacent Land's End Granite. The different types of mineral assemblages within the hornfelses indicate different phases of replacement both prior to and during granite intrusion. This is a key site for studying the complexities of chemical and mineralogical change brought about by element mobility and the reactions that occur in rocks of differing composition and origin.

References



(Figure 4.21) Massive cliff section composed of various banded, amphibole-hearing, basic hornfelses of volcanic origin. In, the foreground is a small irregular raft of metasediment caught up during the emplacement of the basalts. Tater-du. Cornwall. (Photo: P.A. Floyd.)

(Figure 4.22) Typical, banded, basic hornfels of volcanic origin, composed of dark layers of hornblende and biotite, with light-coloured, segregation lenses of diopside. Tater-du, Cornwall. (Photo: P.A. Floyd.)