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On the occurrence of welded tuffs around Ingaldhal, Chitradurga, Karnataka, India

RAJU PHILIP

Abstract

The note records the occurrence of nine different varieties of metavolcanic tuffs noticed around Ingaldhal such as breccia type, fine laminated type with graded bedding, laminated type with medium sized fragments, fine sericitised type with amygdales, devitrified glassy type, crystal tuff, ash flow type, brown sandstone type and type showing subparallel to radial structures. On the basis of the texture and structure exhibited by these rocks the possible mechanism of eruption is discussed. The relationship between sulphide mineralisation and tuff horizon has shown that structural control in ore localization is only of secondary importance at Ingaldhal.

Introduction

During the course of a detailed study of the sulphide occurrences around Ingaldhal (14°12′N, 76°27′E) near Chitradurga in Karnataka State, different varieties of metavolcanic tuffs were encountered.

The chief object of the present paper is to bring out the varieties of tuffs noticed around Ingaldhal and to correlate their relationships with sulphide mineralization.

Geology of the area

This report is mainly based on an area covering about 240 sq km around Ingaldhal, which is about 6.5 km southeast of Chitaldrug. The rock types noticed are conglomerates, sandstones, chlorite schists, phyllites, banded cherts, tuffs and a differentiated suite of metavolcanics, such as basalts, variolitic traps, andesites, keratophyres, trachytes and rhyolites. Apart from these, there are also dykes and granites of varying composition.

Description of the tuffs

At Ingaldhal, the closing stage of volcanic activity is represented by rocks which can be described as welded tuffs. Most of the previously decribed 'traps' from the area belong to the group of welded tuffs. Nearly nine different varieties have been distinguished with the help of structural, textural and mineralogical studies. Their close association with conglomerates, banded cherts, acid volcanics like rhyolite, trachyte and keratophyres suggests their formation during the final stages of volcanic activity. The varieties identified are:

1. Breccia type, coarse fragmented reworked.
2. Fine laminated type with graded bedding.
3. Laminated type with medium size fragments.
4. Fine sericitised type with amygdales filled up by secondary quartz.
5. Devitrified glassy type with cleavages.
6. Crystal tuff
7. Ash flow type with distinct laminations.
8. Brown sandstone type.
9. Type showing sub-parallel to radial structures.

Type 1: is noted for the laminated spindles and angular pieces of pumiceous rock (Fig. 1) that are cemented in a highly fine-grained laminated matrix. Some of these angular pieces contain disseminations of polymetallic sulphides. The fine laminations in the fragments (tuff lavas?) show minor foldings and fractures, which are later filled up by secondary quartz. The light green chlorites developed are studded with fine crystals of zoisite. Globulites of devitrified volcanic glass are scattered in the laminated sericitised pieces. The cementing material is impregnated with plates and specks of calcite. Fine plates and needles of tremolite-actinolite having positive elongation can be traced. Minor pyrrhotite with corroded margins occurs as stringers. This type is taken as an example for reworked tuff, since the coarse fragments retain primary laminations discordant with those of the matrix. This implies polyphasic eruption, with intervening periods of quiescence.

Type 2: is located near the minerlised zone in level-II of the mine workings. The rock is jet black in colour and is traversed by quartz-sulphide veins. it is interlaminated with fine to medium grained quartz with devitrified spindle shaped fragments. The fine grains are almost opaque, and their alignment gives rise to distinct laminations. Alignment of pyrrhotite laths and specks along laminations indicate syn-sedimentation age for the sulphide.

Type 3: the fragments are ellipsoidal to discoidal, intermixed with fine chloritic matter; the rock shows laminated nature. At places, some of these laminae have developed distinct crenulations, suggestive of disturbance during the time of deposition. This type is noted for polysulphide disseminations.

Type 4: is abundantly developed on the western flank of Belligudda. It is well cleaved, fine grained, sericitised and chloritised, with amygdales filled up by secondary silica. Most of these amygdales are closely spaced with concentric arrangement of silica layers around each thus giving a zonal look. Around the margin of some of the amygdales radiating clusters of tremolite are noticed.

Type 5: in the mineralised zone, is rich in clusters of tourmaline and chlorite. The rock consists essentially of devitrified glass, which is partially cryptocrystalline and shows a feeble anisotropism. Later shearing has affected both the enclosing lode and the associated rocks.

Type 6: is well developed on the south-western flank of Belligudda and NW of Yerehalli. In hand specimen it is a dark brown compact rock seen interlaminated with fine bands of chlorite schist. Euhedral quartz (Fig. 2) sometimes with corroded margin and devitrified spindle shaped fragments of volcanic glass are embedded in a highly fine grained and layered ashy matrix.

Type 7: is cleaved, and at places puckers have developed. Primary banding is distinct, and each lamina has a thickness of roughly 1 cm and made up of very fine grained material. The flow texture is made conspicuous due to the alignment of fine lenticular bodies of silica with their longer axis parallel to the laminations. These laminations are intermixed with medium to coarse fragments of quartz having corroded margins. Some of these flow laminations retain the imprint of deformation since they exhibit minor undulations. Because of the distinct laminations and flow texture with penecontemporaneous deformation features, the term 'ash-f ·v tuff' fits well.

Type 8: is brownish, massive and has the appearance of sandstone, but the rock is lighter than sandstone and partially porous. It is seen as a lenticular patch in association with pyroxene bearing traps. The rock is mainly made up of fragments of a yellow or brown substance similar to basaltic glass. Generally the tuffs in association with basaltic rock are of this nature (Johannsen, 1949, p. 302).

Type 9: is noted for the subparallel to radiating markings, developed in a highly fine grained matrix. Some of these features are retained in the secondary siderite grains. The markings probably are ghost relicts of devitrification shrinkage cracks.

Mechanism of eruption of the Ingaldhal tuffs

Mainly three eruptive mechanisms have been proposed for welded tuffs (Boyd, 1961) such as:

(a) Tuff flow or pyroclastic flow mechanism.

(b) Froth flow mechanism

(c) Ash fall mechanism.

The concept of tuff flow mechanism is developed after the observations of Nuees Ardente and the tuff eruption in the valley of Ten-thousand Smokes. Supporters of this view (in Boyd, 1961; Marshall, 1935, p. 14; Gilbert 1968, p. 1851) believe that a welded tuff is emplaced as an avalanche of fine particles of viscous melt and

Figure 1. Welded tuff showing spindle shaped and angular pieces of pumiceous rock materials.

occluded gas at high temperature. The movement of the avalanche is dominantly controlled by gravity. Such a type of avalanche inflated by gas would be fluid and thus facilitate emplacement at a rapid rate. When it comes to rest the deposit gets compacted; and it is assumed that the finely comminuted fragments of melt would retain enough heat to deform and weld.

The texture and structure of the Ingaldhal tuffs support the view that they were emplaced as pyroclastic flows. Type (1) grouped as reworked tuffs indicates the prevalence of two different mechanisms in their formation. The occurrence of pumiceous fragments embedded in a fine matrix supports mechanism (b) as the earlier phase of eruption, and the fragmentation of the former supports mechanism (a) in their final phase of emplacement.

There was possibly a gradational eruptive sequence from lava flows, with little exsolving gas, to pyroclastic flows, in which the gas pressure was sufficient ultimately to give rise to the reworked tuff.

Relationship between the tuff and sulphide mineralization

At Ingaldhal, the pyrite-pyrrhotite rhythmites confined to the banded cherts are noted for their remarkable extension in space running for a length of more than 10 Km. Some of these sulphide bands are noted for graded bedding and features characteristic of penecontemporaneous deformation, like slumps and load casts. At some places type (2) tuff is seen in close association with the banded pyrite-pyrrhotite rhythmites in a conformable pattern. The rhythmites exhibit evidence of having been laid down by aqueous mass transport mechanisms (e.g. slides and slumps, presumably triggered by volcano-tectonic shocks) and are allochthonous, exhalative resedimented material. The features shown by the ash flow tuffs (type 7) register similar phenomenon and the association of the sulphide-rhythmite with the tuffs signify a similar depositional history for both.

Figure 2. Crystal tuff. Note the euhedral quartz present at the bottom. 90 × Transmitted light.

As reported by Radhakrishna (1967), Pathan and Naganna (1970) the sulphide mineralization is stated to be confined to the sheared traps. But the present study shows that the quartz-sulphide veins are confined within the primary bandings of these layered tuffs and later regional metamorphism has deformed these bandings to give rise to discordant types of veins originating from the parent concordant veins along fractures developed on fold arches.

Structural control in ore localization is of secondary importance at Ingaldhal. It may be locally instrumental in accommodating a copper rich ore shoot within or near the main ore body, by plastic flowage. On a regional scale stratigraphic considerations should play a decisive role.

The cleaved tuff (including types 2, 4 and 5) occurring interbanded with the variolitic trap-keratophyre-banded pyrite-pyrrhotite cherts is found to be the host rock at the Ingaldhal mine. Attention should be confined to this and similar tuff bands which occupy analogus positions in other cycles of volcanism to trace possible sulphide occurrences.

Conclusion

The close association of welded tuffs with conglomerates, banded cherts and acid volcanics, like rhyolite, trachyte and keratophyres, suggest, their formation during the final stages of volcanic activity. Confinement of polymetallic sulphide mineralization within the tuff horizon highlights the role of lithology combined with stratigraphy as guides for future exploration.

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Address of the author

RAJU PHILIP, Department of Geology, University of Kerala, Kariavattam, Trivandrum.