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Note on dolerite, rhyolite, and granophyre in the basement of the Tenggol Arch, offshore Terengganu

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Abstract: The basement of the Tenggol Arch is penetrated by PETRONAS Carigali well Malong 5G-17.2, located 150 km off the east coast of Terengganu. Cores from the basement, at 1,582 m subsea, consists of highly fractured porphyritic rhyolite in sharp contact with a dolerite dyke. Overlying the rhyolite is a lower Miocene conglomerate composed of rhyolite and granophyre clasts. The granophyre clasts were presumably derived from a granophyric basement subcrop in the vicinity. The dolerite dyke in Malong well occurring at the edge of the Malay Basin may have been intruded during incipient rifting of the basin during the early Cenozoic.

INTRODUCTION

The basement to the Tertiary basins offshore Peninsular Malaysia has been penetrated by some exploration wells, but the nature of the basement rocks has not been described in detail. This paper describes igneous rocks in cores from the basement at Malong 5G-17.2 well, drilled by PETRONAS Carigali in 1984 on the Tenggol Arch, offshore Terengganu. Igneous rock fragments also occur in the Tertiary sedimentary rocks overlying the basement, and are also described.

GEOLOGICAL SETTING

The Tenggol Arch is a shallow pre-Tertiary basement horst that separates the Malay and Penyu basins. The Malong 5G-17.2 well, located approximately 150 km off the Terengganu coast (Fig. 1), was drilled on a basement-drape structure (Ng Tong San, 1987) and encountered basement at 1,582 m subsea. Cores were taken almost continuously between 1,482 and 1,589.4 m subsea. This study describes the lower 10 m of the cored interval, representing the basement and overlying lower Miocene coarse-grained siliciclastic rocks.

DESCRIPTION OF BASEMENT ROCKS

The Malong cores, summarised in Figure 2, comprise two types of igneous rocks in the basement: rhyolite and dolerite. These rocks are described below.

Rhyolite

The rhyolite is pale yellowish brown ("wet" Munsell colour: 10YR 6/2) to very light grey (N8) and porphyritic, with pink or white alkali feldspar phenocrysts.

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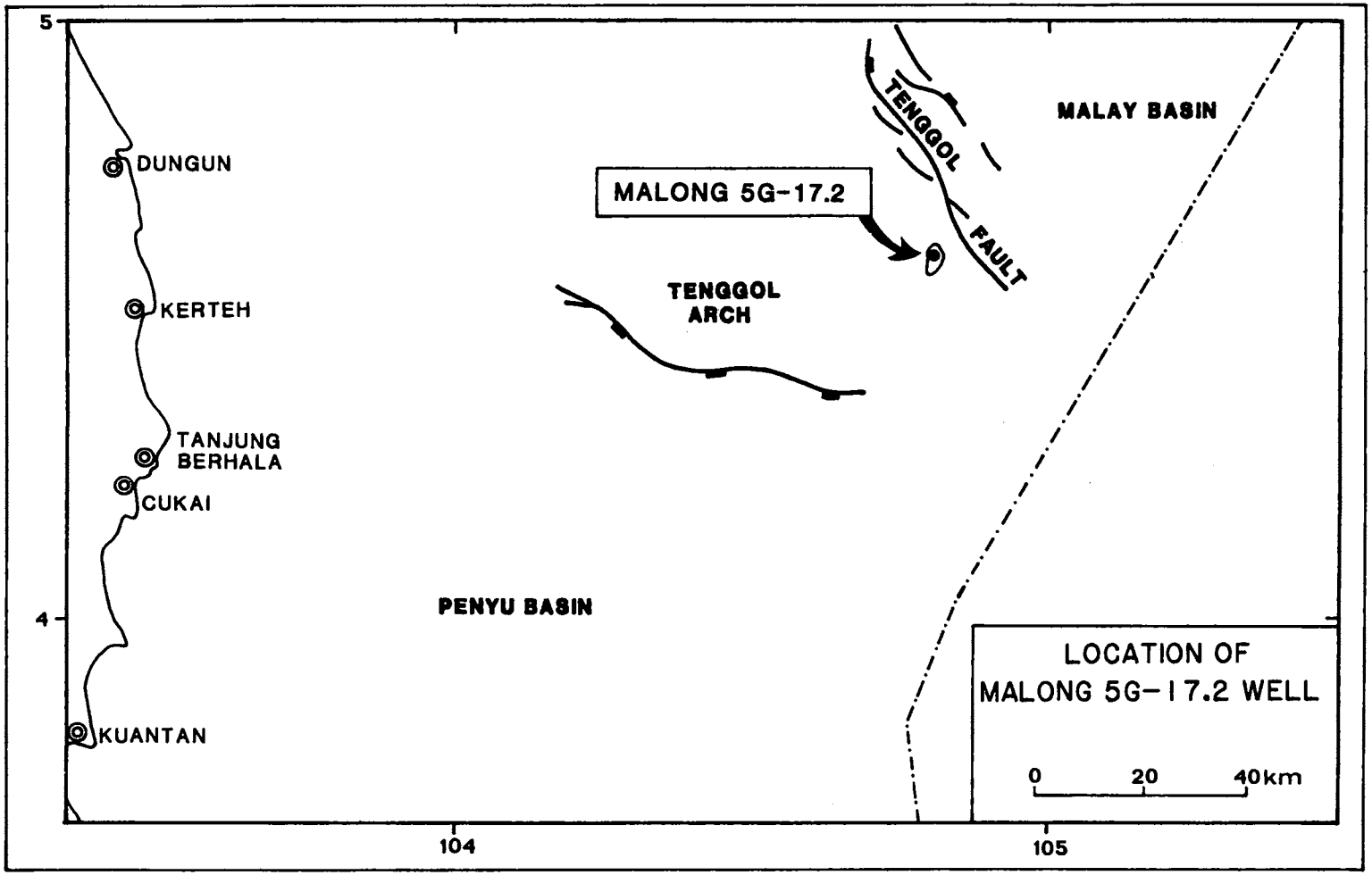

Figure 1: Location of Malong 5G-17.2 well.

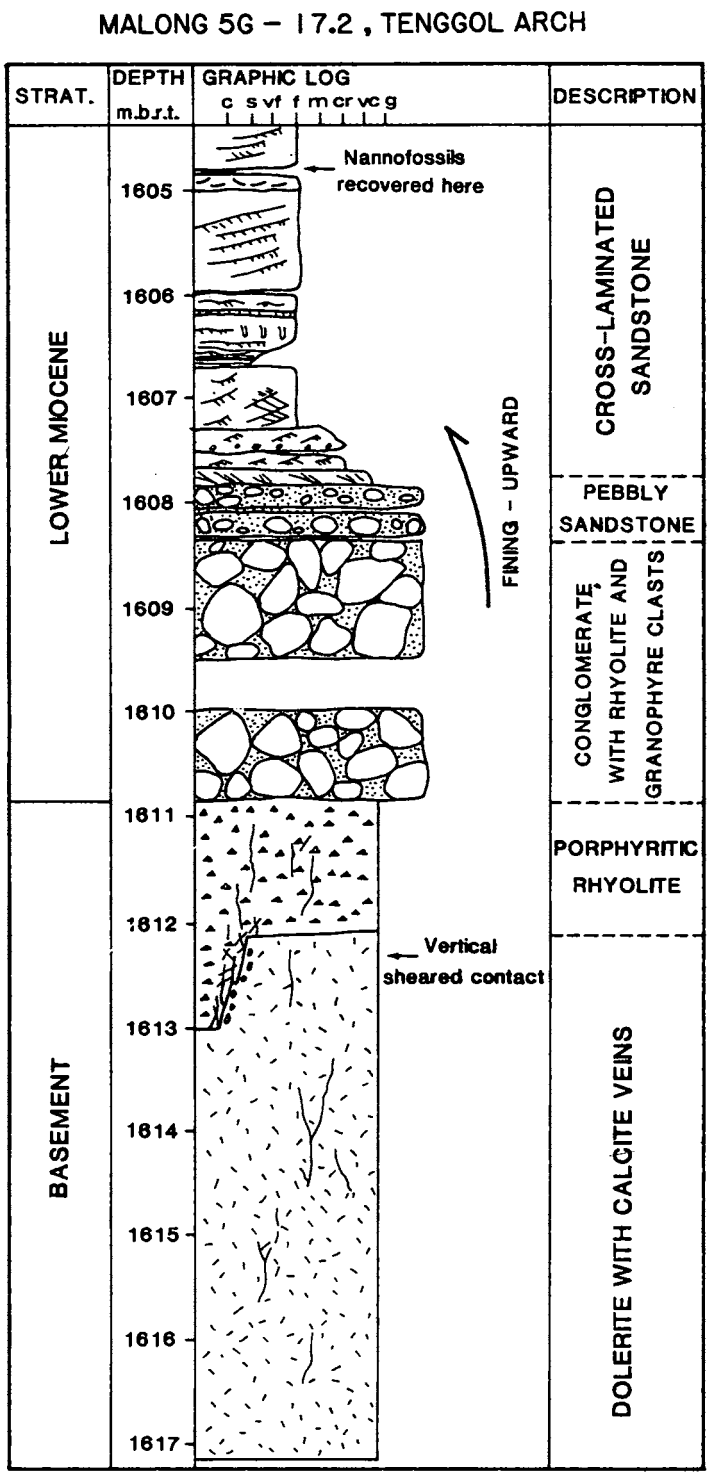

Figure 2: Summary of lithology observed in the core interval from Malong 5G-17.2 well. Core depth in meters below rotary table (m.b.r.t.).

The rhyolite is highly fractured and sheared at the contact with the dolerite (Fig. 3), with the intensity of fractures decreasing away from the contact.

In thin section, the rhyolite is cryptocrystalline, and shows extensive devitrification texture (Fig. 4). The feldspar phenocrysts (ca. 1 mm across) are subhedral, occur as clusters (glomerocrysts) in places, show mainly lamellar twinning, and are commonly discontinuously zoned (Fig. 4). Anhedral zircon crystals are present.

Dolerite

The dolerite is greenish black (5G 2/1) and massive, and is cut by mm-thick secondary ferroan calcite veins (Fig. 5). In thin section, the dolerite is very fine grained and microporphyritic (Fig. 6). It has an intersertal texture, produced by plagioclase laths (< 1 mm long) in a greenish (?chloritic) groundmass. The margin of the dolerite contains fragments of rhyolite and fractured feldspar xenocrysts (Figs. 3D, 7).

LOWER MIOCENE CONGLOMERATE

The rhyolite (basement) is overlain by a 3 m-thick conglomerate at the base of a lower Miocene sandstone-shale sequence (Fig. 2). The conglomerate consists of well-rounded rhyolite and granophyre pebbles and cobbles (as much as 20 cm across) set in a coarse-grained sandy matrix (Fig. 8). No dolerite clasts were found in the conglomerate.

The rhyolite clasts are light grey, very fine grained or "glassy", and porphyritic with white feldspar phenocrysts (Fig. 8A). The granophyre is pinkish grey (5YR 8/1), fine to medium grained, equigranular (< 1 mm grain diameter) and aphyric, composed of pink alkali feldspar, quartz, and trace zircon. Thin sections show common granophyric quartz-feldspar intergrowths (Fig. 8B). Graphic or granophyric texture is also visible in hand specimen.

The matrix of the conglomerate is formed of medium to coarse-grained quartz and feldspar, some of which show granophyric texture (Fig. 8C). Euhedral zircon grains are common constituents of the granophyre clasts and sandy matrix (Fig. 8D).

DISCUSSION

The sharp vertical contact between the rhyolite and dolerite, the brecciation of rhyolite at the contact, and the occurrence of deformed feldspar xenocrysts in the margins of the dolerite suggest that the rhyolite is intruded by the dolerite. The latter is interpreted as a dyke. No radiometric dating has been done on these rocks. The highly altered state of the rocks would probably give unreliable results. Effort is being made to get the zircons from the granophyre dated.

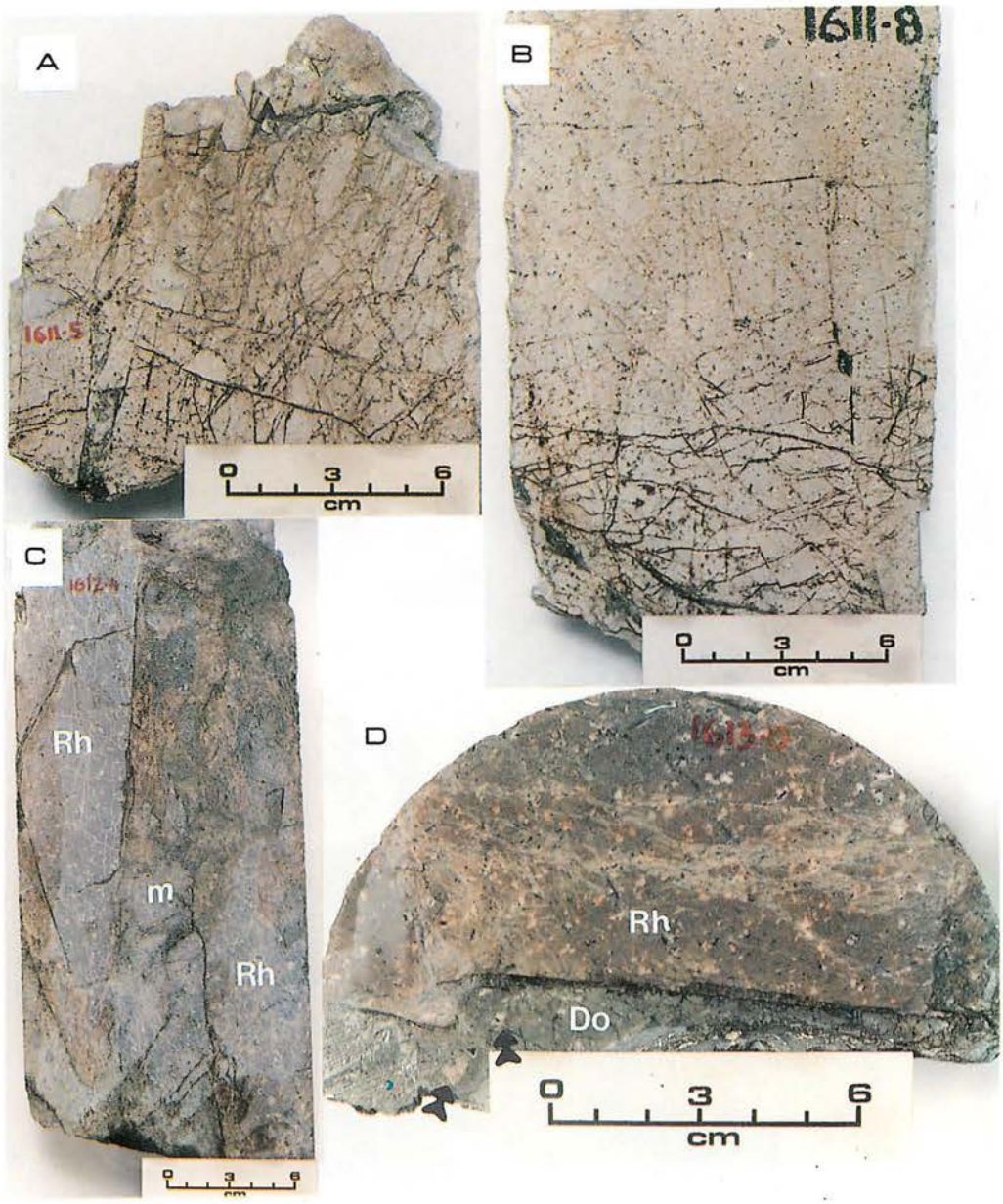

Figure 3: Core samples of rhyolite (Depth in metres written on samples). A. Intensively fractured rhyolite. B. Rhyolite showing the intensity of fractures decreasing upward away from contact with dolerite. White feldspar phenocrysts are visible. C. Sheared rhyolite blocks (Rh) near contact with dolerite. Greenish "matrix" (m) represents highly sheared and altered rhyolitic material. D. Horizontal section of core showing sharp vertical contact between porphyritic rhyolite (Rh) and dolerite (Do). Intense shearing is indicated by the numerous microfractures cutting through the rhyolite. Xenoliths of rhyolitic material have been incorporated in the margin of the dolerite (arrows).

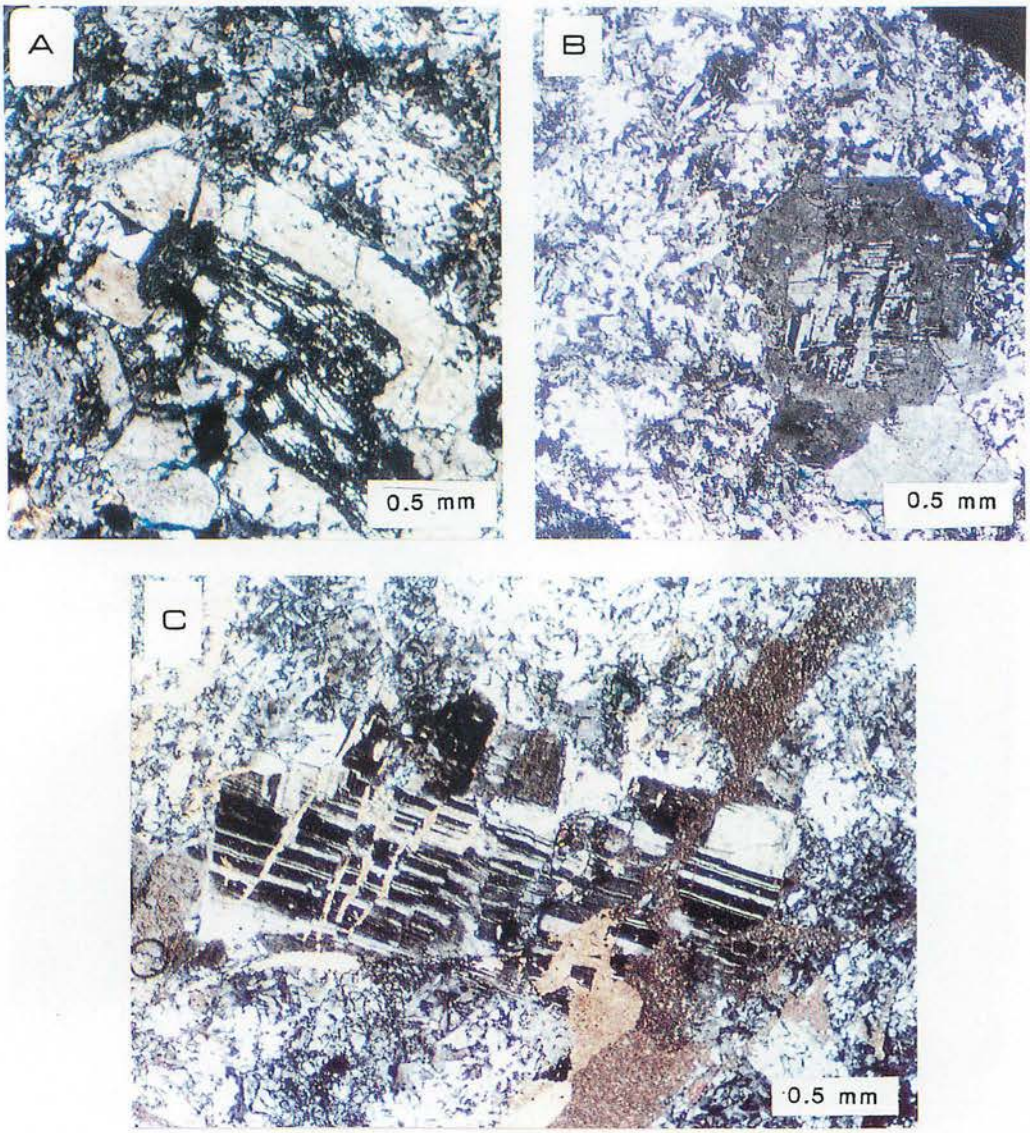

Figure 4: Photomicrographs of rhyolite, showing typical porphyritic texture with alkali feldspar phenocrysts in a devitrified silicate groundmass. Zoning is common in the feldspar phenocrysts (Photos "A" and "B"). Photo "C" is from rhyolite near its margin with the dolerite (see Fig. 3D). Note the carbonate-filled fractures cutting through the feldspar phenocrysts at the centre of the photo. Twinning lamellae are displaced by the fractures. Sample depths: A. 1611.65 m. B. 1611.65 m. C. 1613 m. All under cross-polarized light.

Figure 5: Core sample of dolerite showing fine-grained texture and thin calcite-filled fractures. Depth: 1616 m.

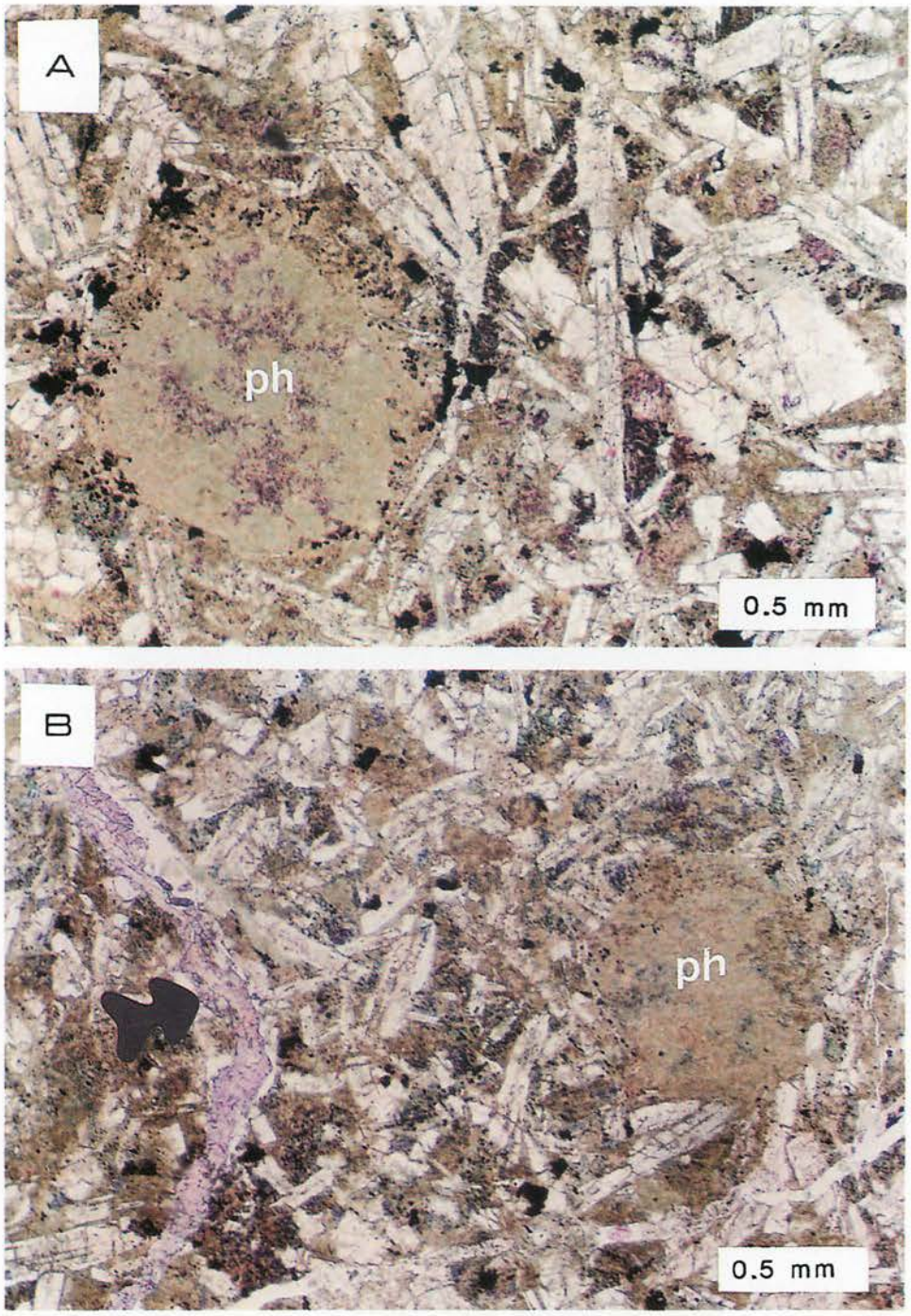

Figure 6: Photomicrographs of dolerite, all in plane-polarized light. A. Plagioclase laths in ?chloritic groundmass producing typical intersertal texture. Large chloritic bleb (ph) appears to be a pseudomorph of a phenocryst, probably olivine. 1616 m. B. Another view of similar features as in "A". This sample has calcite-filled fracture cutting through it (arrow). 1614.5 m.

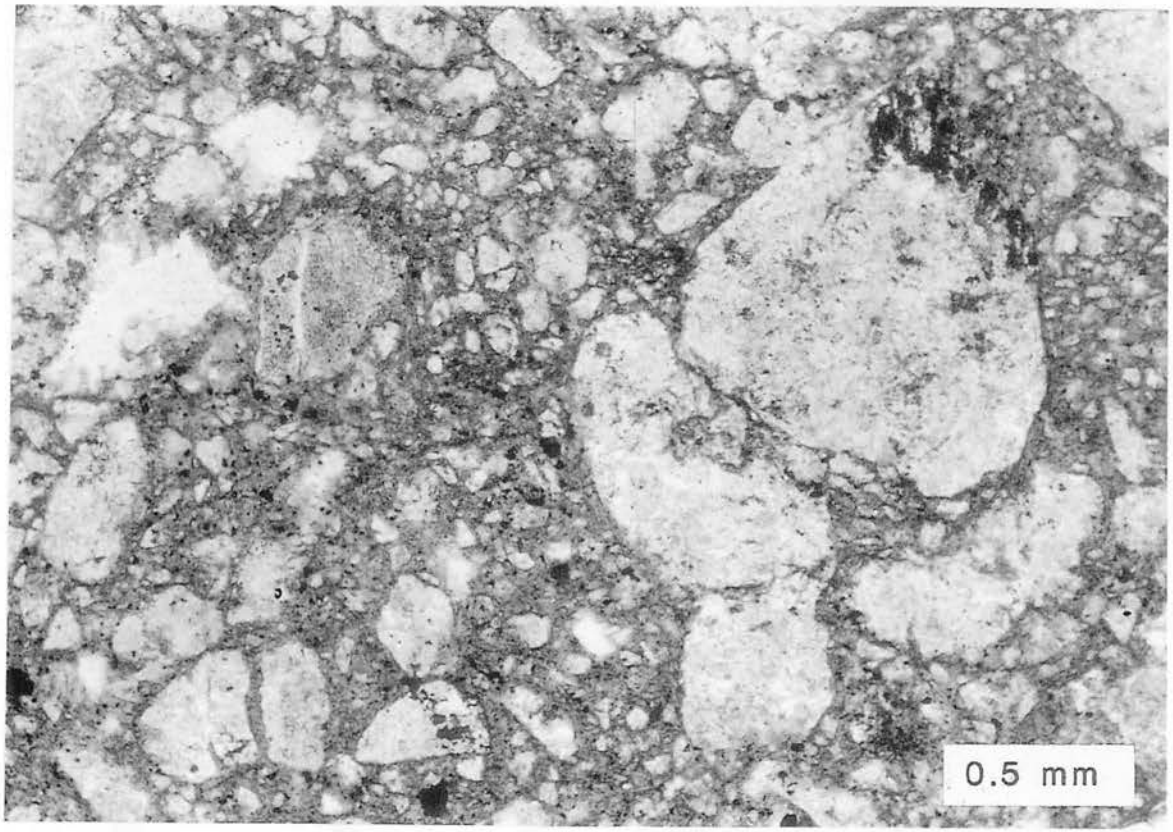

Figure 7: Photomicrograph from the margin of dolerite (see Figure 3D) showing fragments of rhyolitic material in a glassy groundmass, presumably formed by rapid cooling of basaltic melt, now altered to clays. 1613 m, plane-polarized light.

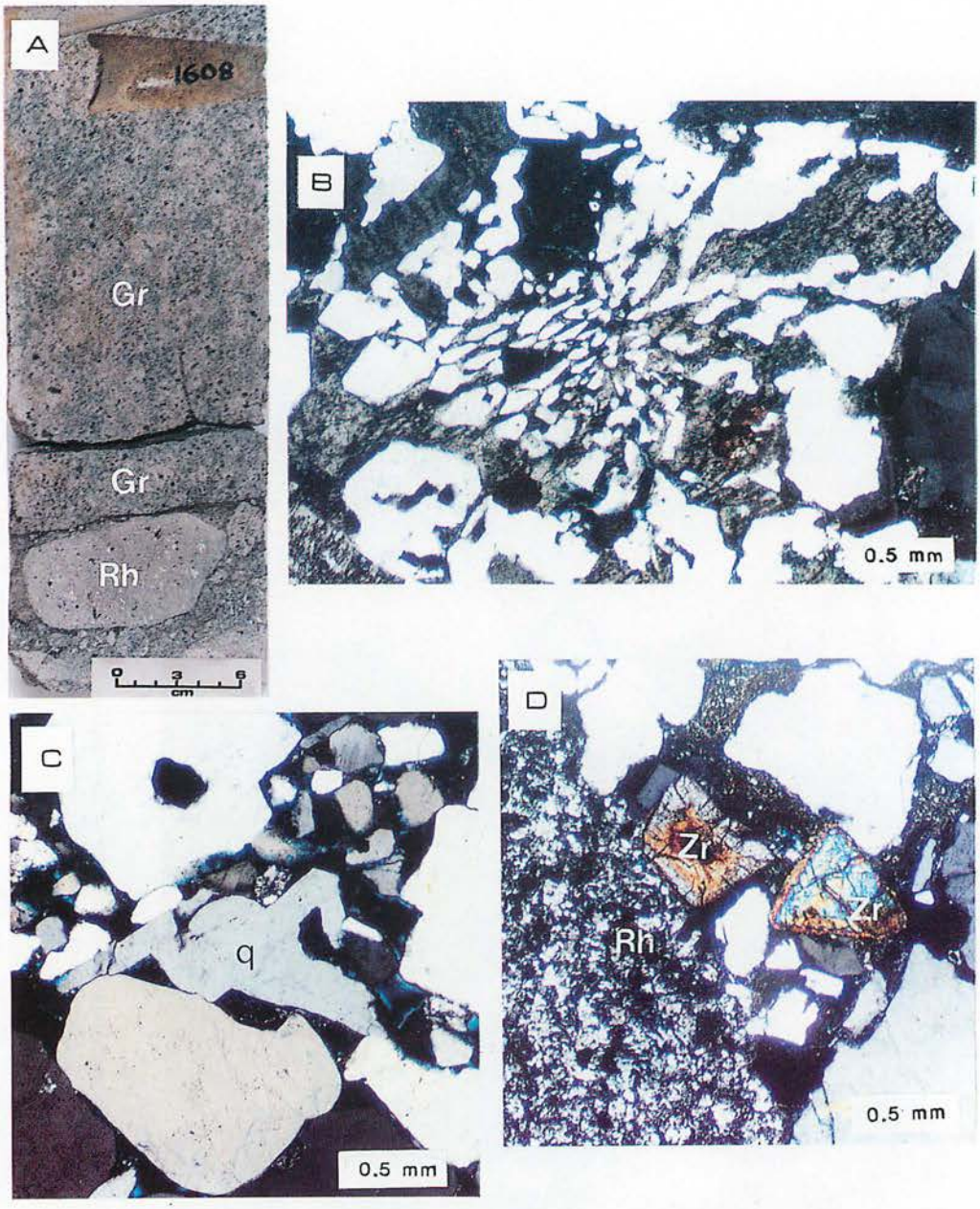

Figure 8: A. Core photograph from lower Miocene conglomerate overlying the basement rhyolite in Malong 5G-17.2 well. This picture shows large granophyre (Gr) and rhyolite (Rh) clasts in coarse-grained sandy and pebbly matrix. Smaller clasts of similar composition are also present. Sample from 1608 m. B. Photomicrograph of a granophyre pebble showing typical granophyric texture formed by intergrowth of alkali feldspar (dark mineral) and quartz (white). Note the radial, outward-increasing size of quartz crystals. 1609 m, cross-polarized light. C. Photomicrograph of sand matrix of the conglomerate. The shape of the quartz grain at centre (q) suggests derivation from a granophyre parent. Note the poor sorting. 1607.95 m, cross-polarized light. D. Photomicrograph showing part of a rhyolitic clast (Rh) in a sandy matrix containing euhedral zircon grains (Zr). Bright grains are quartz. 1607.7 m, cross-polarized light.

The rhyolite may be related to similar silicic volcanic rocks of Triassic age which are widespread in southeast Pahang and east Johor (see Hutchison, 1989, p. 166). If this is true, the dolerite dyke in Malong well must have been intruded sometime during the Jurassic to early Tertiary. Evidence for late Mesozoic to early Tertiary basic igneous events is represented by the Kuantan dolerite dykes (104 Ma, Haile *et al.*, 1983) and the Segamat basalts (62 Ma, Bignell and Snelling, 1977). Basic dykes also occur along the Terengganu coast but are poorly dated (Hutchison, 1989, p. 291). Probable Late Cretaceous to Cenozoic basaltic dykes have been reported from the Tambelan Islands in the Natuna area by Haile (1970).

The dolerite dyke in Malong well, located at the southwestern margin of the Malay Basin, was probably intruded during incipient rifting of the basin in the early Cenozoic.

The granophyre clasts in the basal lower Miocene conglomerate were presumably derived from a pre-Tertiary granophyre subcrop in the basement nearby on the Tenggol Arch.

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