Contact metamorphic aureoles in some Bowen Basin coals.

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INTRODUCTION

When Australia separated along the Lord Howe Rise in Paleocene times, the accompanying volcanic activity of the Whitsunday Silicic Volcanic Province, affected northern Bowen Basin where the Permian coal measures are intruded by numerous igneous dykes and sills presumably related to these events.

Immediately adjacent to the intrusions, the coal seams have been carbonized, and natural coke, characterized by columnar cooling joints perpendiculat to the source of heat, is very commonly found. At the boundary separating the coke from the coal, there is a distinctive layer of coke, called the 'Plastic Layer', where the coal is completely devolatalised and changed to coke. This is a metamorphic front that advances into the coal during the carbonization process. When the heat from the intrusion dissipates, this layer cools and solidifies. The thickness of the Plastic Layer is a function of coal type and rank (Figure 1), and is featured in Chinese and Russian classifications of coking coals. The Saponikhov test measures the thickness of the Plastic Layer in laboratory-simulated tests

Carbonization of coking coals in commercial coke oven batteries involves the loading of a volume of coking coal into a 10m high 'slot oven', and its transformation over about 20 hours into coke. During this time, heat that is applied to the battery walls causes the development of plastic layers at each wall of the oven, which migrate slowly towards the centre of the oven, where they meet at the 'Cauliflower' zone. Any textures that develop in the coal in advance of the plastic layer are therefore overwritten, leaving only the coke.

This poster is concerned with textures and changes to the coal macerals that are preserved in heat-affected coal on the relatively lower temperature side of the Plastic Layer, in rocks that are still identified as coal. These metamorphic changes to the coal can be identified and mapped as (1) start of mesophase growth within vitrinite, (2) the continued development of new carbon forms and disappearance of vitrinite, and (3) changes to the reflectance of vitrinite.

Other changes to the heat-affected coal are manifested as deteriorations tof the measured characteristics that define a coking coal. For example, volatile content, Giesler fluidity and swelling capacity, are all reduced, in these metamorphic aureoles, but these changes are beyond the objectives of this study.

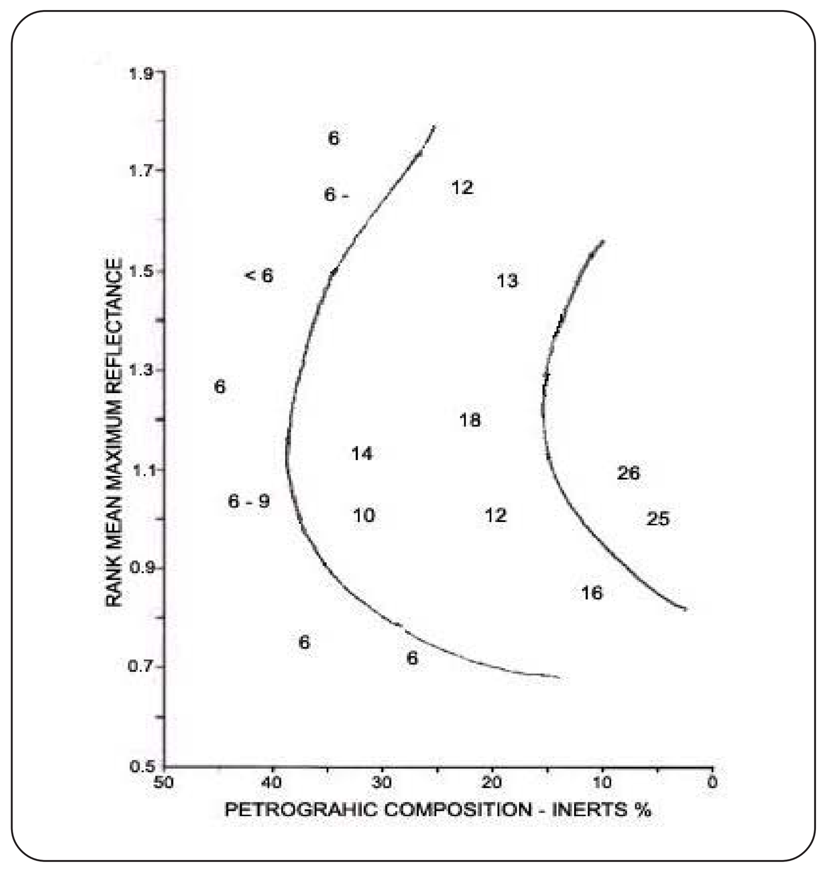


Figure 1. Thickness of Plastic Layer, in millimeters, as a function of Rank and Petrographic Composition

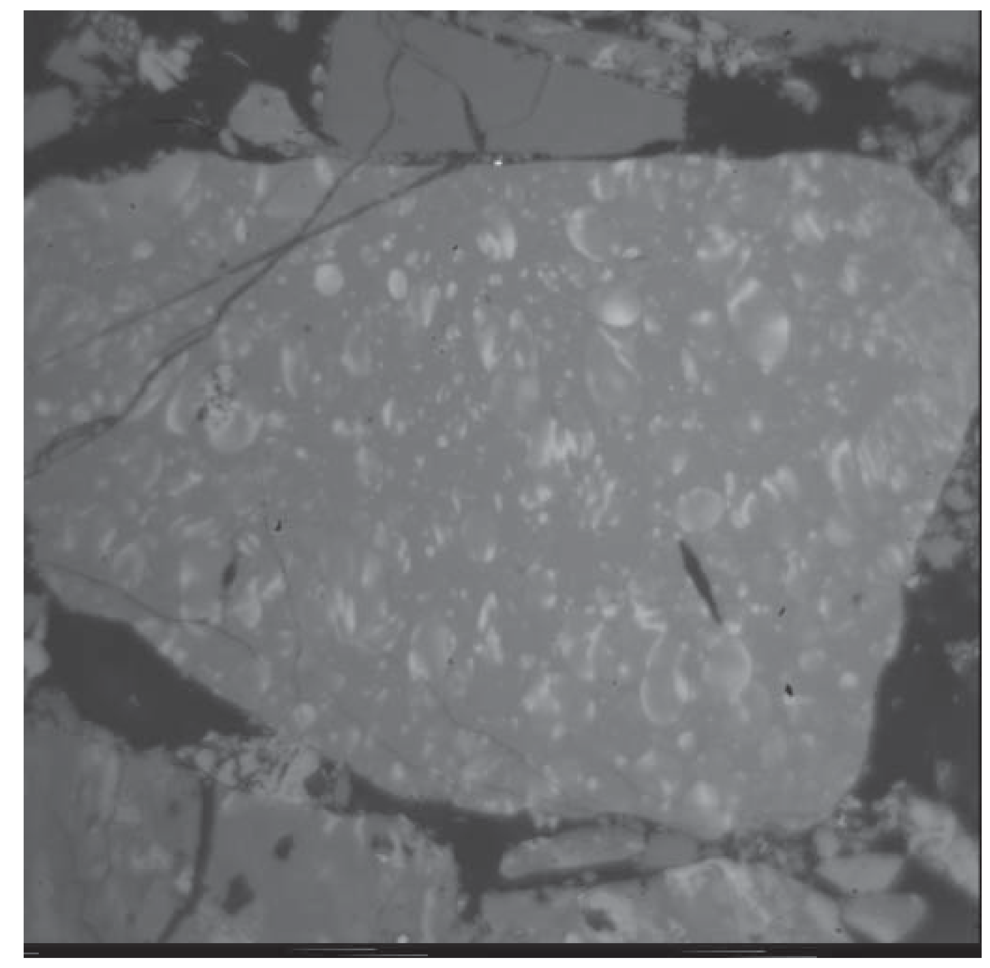


Figure 2. Typical coarse Zone 2, Bowen Basin Mesophase development within Vitrinite. The image is 250 x 250µm Oil immersion x50 NPL lens, in polarized halogen light.

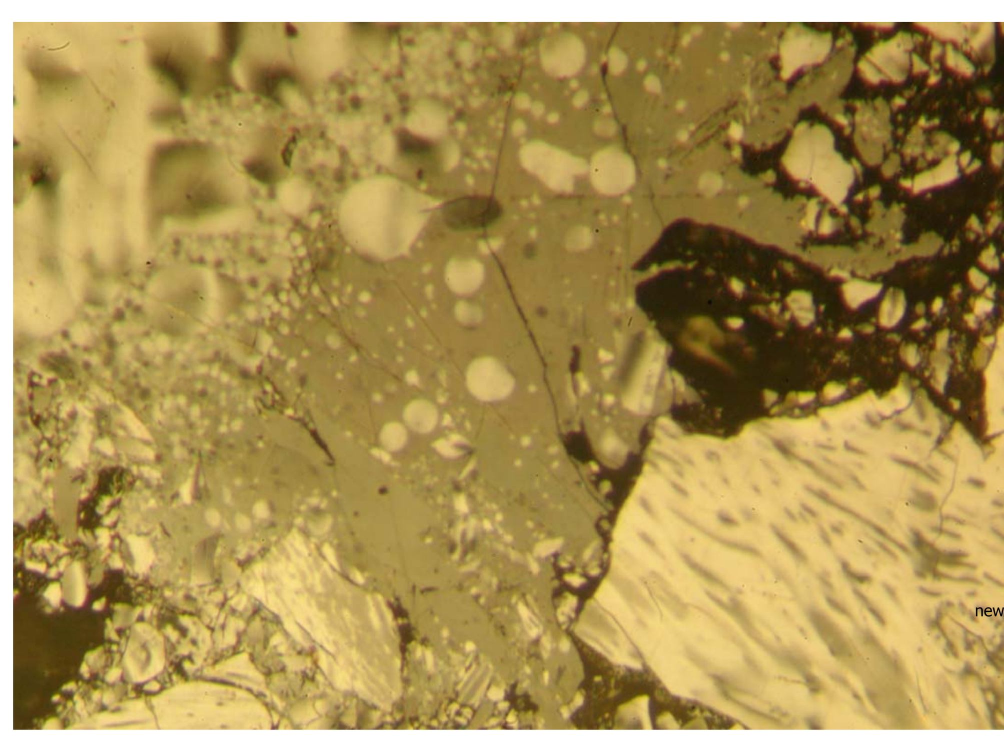


Figure 3.. Mesophase spheres in green petroleum coke. Polarized halogen white light. Oil immersion x50 NPL lens

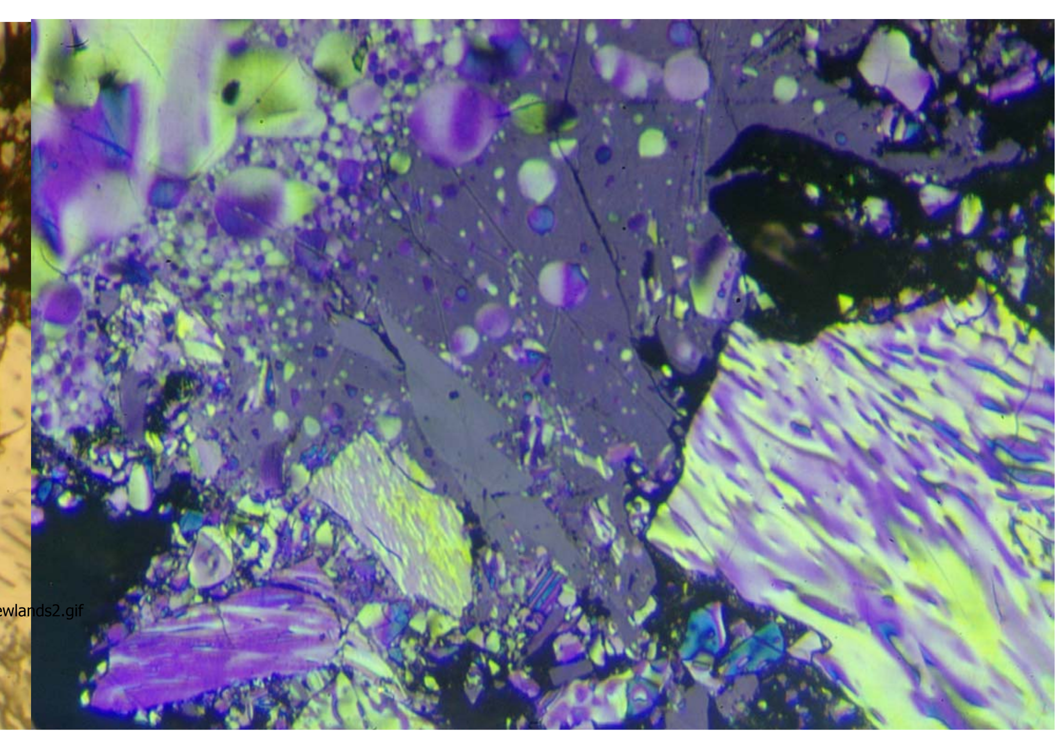


Figure 4. The same image as Figure 3, with crossed polars, retardation plate, under mercury vapour illumination. Oil immersion. x50 NPL lens

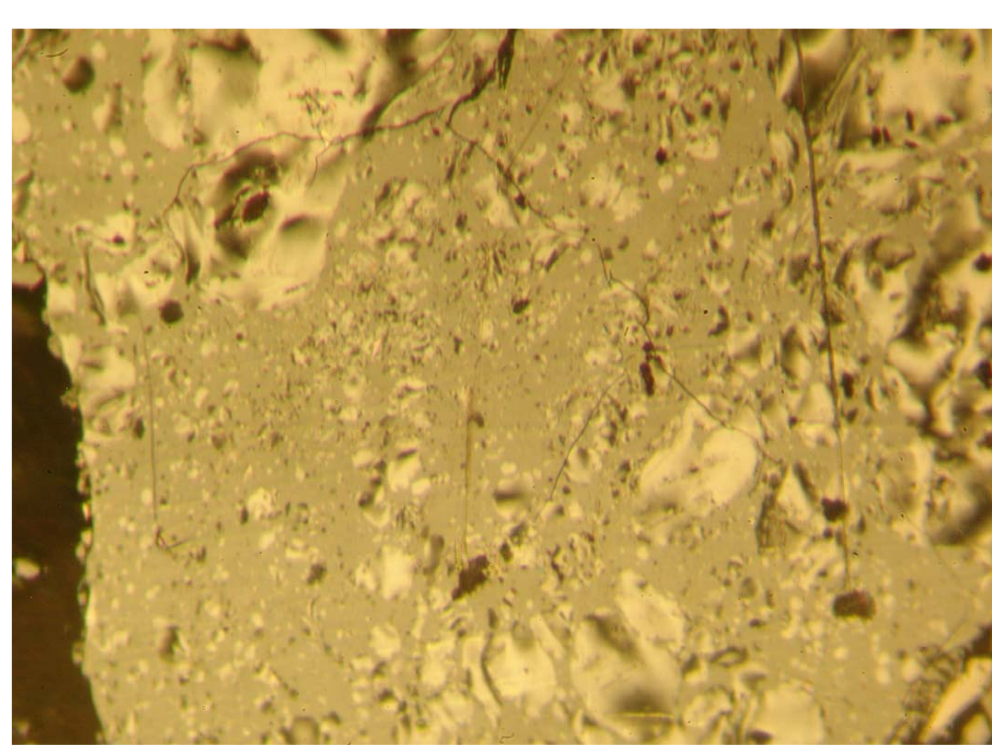


Figure 5. Mesophase spheres in Vitrinite. Bowen Basin coal. Polarized halogen white light. Oil immersion x50

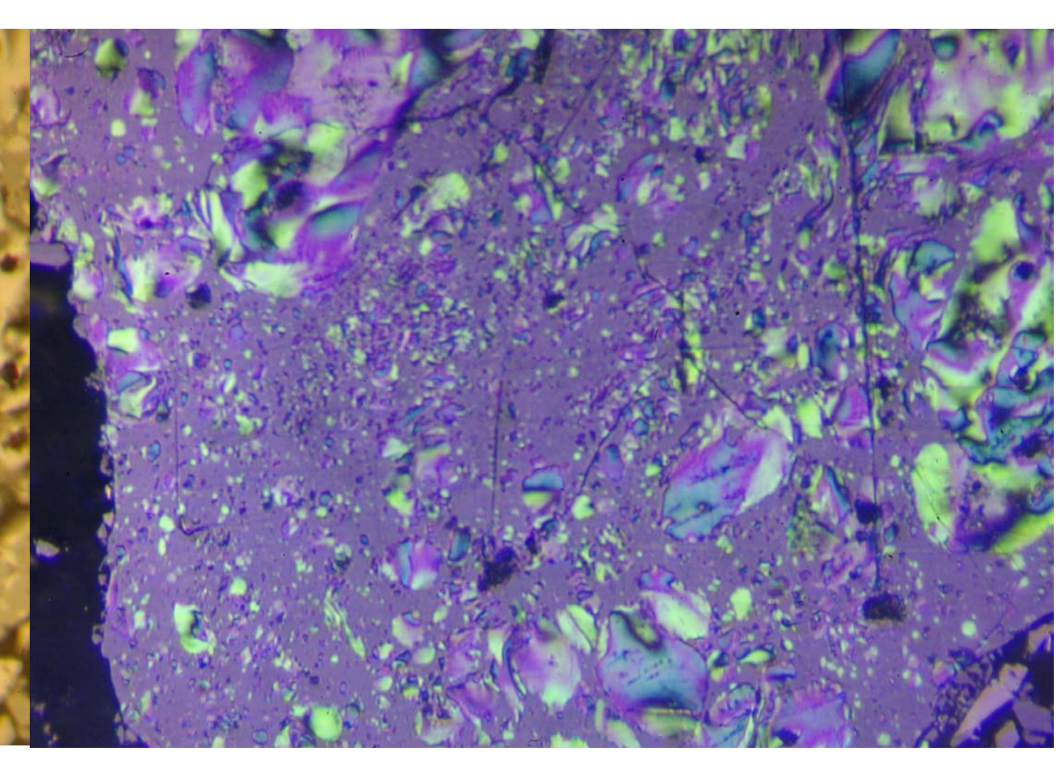


Figure 6. The same image as Figure 5, with crossed polars, retardation plate, under mercury vapour illumination. Oil immersion. x50 NPL lens

ZONES OF PROGRESSIVE CONTACT METAMORPHISM

Two zones of heat-affected coal can be identified in Bowen Basin contact metamorphic aureoles between coal and coke. These are the Mesophase-in-Vitrinite Zone, and the Coalesced Mesophase Zone.

Zone 1. Increased reflectivity of vitrinite, but without the development of new carbon forms.

Zone 2. Spontaneous development of mesophase spheres in vitrinite - **Mesophase Isograd**. Proportion of vitrinite decreases as mesophase development increases.

Zone 3. Coalesced mesophase ocurrs side-by-side with semifusinite and other inertinites. Vitrinite content of coal now approaches zero - **Vitrinite Disappearance Isograd.**

Zone 4. Natural coke, usually displaying columnalar jointed cooling surfaces, is separated from Zone 3, by the plastic layer, and is characterized microscopically by golden-coloured carbon forms with large vacuoles.

1. MESOPHASE ISOGRAD

The recognition of mesophase spheres in Vitrinite is the first identifiable new microscopic feature that confirms the presence of a thermal aureole. Mesophase spheres occur in vitrinite that has already experienced a rise in reflectance.

2. VITRINITE-DISAPPEARANCE ISOGRADE

Coalescence of mesophase spheres happens at the expense of vitrinite, and the second identifiable feature is the presence of inertinites with coalesced mesophase, *and no vitrinite*. The reflectance profile has no vitrinite peak.

3. VITRINITE ISORTEFLECTANCE ISOGRADS

The spactial relationship of isograds to intrusions can be appreciated by contouring Romax data of equal values. Romax from bore core and from surface outcrop increases towards the intrusive body.

CONCLUSION

The presence of very rare, and highly distinctive new carbon forms in some Bowen Basin coals are evidence of heat affected coal. They are only found in close proximity to igneous intrusions. The extent of heat affected zones can be clearly defined if these textures are identified in bore cores, and their significance understood.

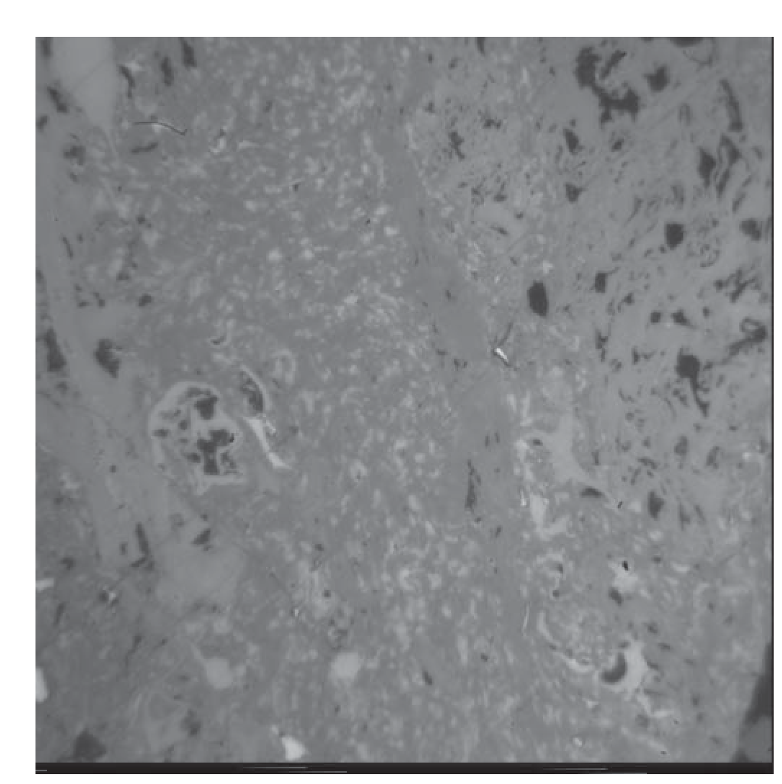
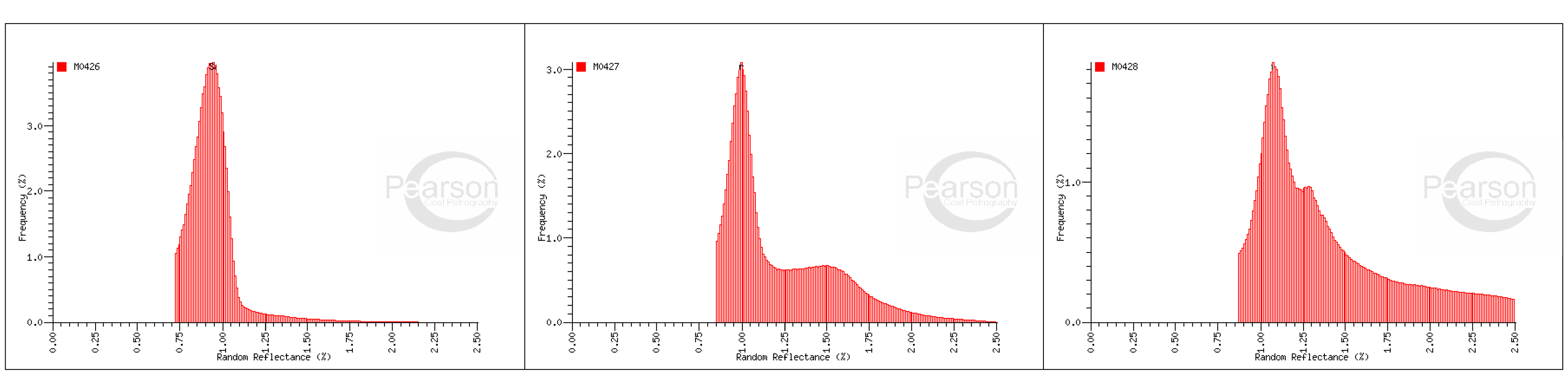


Figure 7 An example of banded semifusinite and coalesced mesophase from Zone 3 Bowen Basin coal. The image is 250 x 250µm. Oil immersion. x50 NPL lens

Figure 8 (Right). The three reflectance profiles show a progressive increase in Contact Metamorphism from left to right.Romax (Vitrinite rank) increases from 0.97% to 1,04% to 1.13%, and as mesophase develops, vitrinite content drops from 80% to 45% to 38%. Finally, when all the vitrinite is converted, the vitrinite peak disappears (not shown).



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