Geology and metallogeny of the Mt. Carlton district, Bowen Basin (NE Australia)

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Palabras Clave: Palabra 1, Palabra 2, etc. | **Key Words:** Keyword 1, Keyword 2, etc.

INTRODUCTION

NE Queensland, Australia is characterized for hosting abundant magmatic-hydrothermal mineral deposits related to Carboniferous and Permian magmatism (Henderson, 1980; Champion and Bultitude, 2013). Some of these deposits are located in the northern tip of the Bowen Basin, 150 km south of Townsville. Evolution Mining holds the ground of the Mt. Carlton district that includes the only deposit currently in production, the Mt. Carlton Au-Cu-Ag deposit (Sahlstrom et al., 2018), and several other prospects of porphyry copper, high-sulfidation and low-sulfidation epithermal type mineralization.

In this study, we present a detailed chronostratigrapy based on newly obtained LA-ICP-MS U-Pb zircon dating in order to distinguish the different volcano-plutonic events through time. Additionally, we also provide a new and complete geochronological work on the different mineral prospects based on step-heating Ar-Ar (alunite, illite and adularia), to correlate volcano-plutonic stages with mineralization events.

GEOLOGY

The Bowen Basin is an elongate, north-trending, asymmetrical coal-bearing basin extending from northern New South Wales through central Queensland covering an area of ~200,000 km². It was formed during the Early Permian, as a back-arc basin of the Connors arc, filled up with the syn-rift volcanic rocks of the Lizzie Creek Volcanic Group (Korsch et al., 2009). The late Permian-Triasic Hunter-Bowen Orogeny (~265-235 Ma) led to foreland loading, tectonic inversion, and development of a foreland basin. Terrestial sediments deposited in the foreland basin make up the bulk of the Bowen Basin infill, including the economically important coal deposits.

The basal unit of the Bowen Basin sequence, which locally overlies the Urannah batholith (341-279 Ma), comprises the Lizzie Creek Volcanic Group (Malone et al., 1964). This unit is the main host for all the known deposits and prospects of the Mt. Carlton district. It consists of early Permian (297-283 Ma) basaltic to rhyolitic volcanic rocks deposited subaerially locally interbedded with sandstones and siltstones and minor coal seams deposited in fluvial and lacustrine environments (Cross et al., 2012; Donchack et al., 2013).

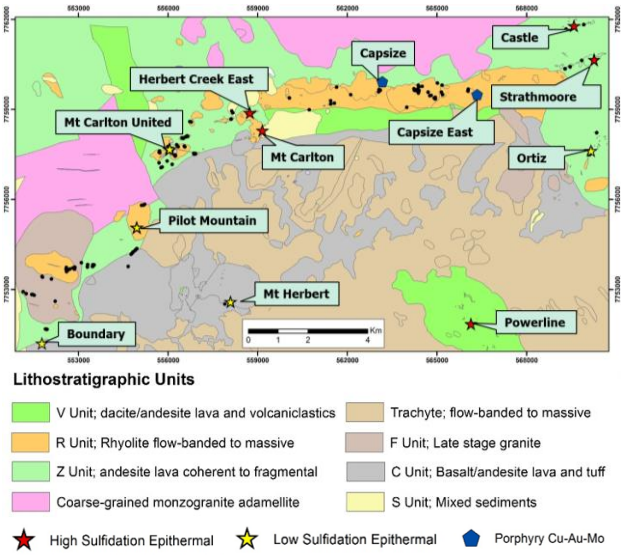

Fig 1. *Geologic map of the Mt. Carlton district.*

CHRONOSTRATIGRAPHY

The different plutonic, volcanic and volcanosedimentary units cropping out in the Mt. Carlton district (Fig. 1), are described below from the oldest to the youngest.

The Urannah batholith is a monzogranite. This unit crops out mostly to the north and west of the district. Three samples have been dated, providing an age range from ~296 to 307 Ma.

The Lower basalt/andesite unit discordantly overlies the Urannah batholith, however the contact has always been observed tectonized. This unit is composed of andesites and basalts. Three samples provided an age range of 287-288 Ma.

The Rhyolite unit is the main deposit host rock. It is deposited on top of the Lower basalt/andesite unit. It is composed of flow banded to coherent rhyolites, rhyolite breccias, rhyolitic tuffs and is locally interbedded with

volcaniclastic and lacustrine sediments. Five samples provided an age range of 277-281 Ma.
The Volcanic/volcaniclastic unit is composed of dacites, ignimbrites, andesites, and volcaniclastic rocks. These rocks overly the rhyolite unit, although locally they are interbedded. Six samples provided an age range of 270-280 Ma.
The Trachyte unit that overlies all previous units, is a rhyolite with well-developed trachytic texture. Two samples have been dated providing an age of 275-276 Ma.
Subvolcanic intrusions of granitic, rhyolitic and andesitic composition with porphyritic texture intrude the entire volcanic sequence. They locally develop porphyry copper-type alteration mineralization. Ten samples have been dated providing an age range of 285-118 Ma.

GEOCHRONOLOGY OF MINERAL DEPOSITS AND PROSPECTS

Re-Os of molybdenite from a quartz-molybdenite vein yielded an age of 285 Ma, records the oldest porphyry-type mineralization in the Capsize prospect.
Porphyry-related lithocap alteration (advanced argillic) characterized by quartz-alunite-dickite/kaolinite-diaspore-pyrophyllite occur in the Mt. Carlton district in an area of >16 x 5 km. This alteration is locally associated with high sulfidation epithermal mineralization (enargite-pyrite-chalcopyrite). This alteration/mineralization encompasses several prospects in the district, such as Capsize, Castle, Strathmoore, Herbert Creek East and Mt. Carlton United, and the Mt. Carlton Au-Cu-Ag deposit. They have a wide range of age, from 285 to 260 Ma (Ar-Ar alunite).
Low sulfidation quartz and quartz-adularia epithermal vein prospects are characterized by a well-developed illite alteration halo. These prospects are peripherally located with respect to the porphyry and high sulfidation epithermal prospects. The Powerline, Boundary, Mt. Herbert, Pilot Mountain and Ortiz prospects range in age from 277 to 254 Ma (Ar-Ar illite and adularia).

DISCUSSION AND CONCLUSIONS

According to the geochronological data presented here, different magmatic-hydrothermal events linking volcanism/magmatism with mineralization events can be envisaged (Fig. 2).
The first event occurred at ~285 Ma. The Lower basaltic/andesite unit was emplaced, with coeval subvolcanic intrusions that produced porphyry-type and lithocap-type alteration/mineralization (Capsize porphyry and Mt. Carlton United).
The second event occurred at ~277 Ma. The Rhyolite unit together with the Volcanic/Volcaniclastic unit and the Trachyte unit were emplaced, with coeval subvolcanic intrusions that produced lithocap-type alteration/mineralization. The Mt. Carlton deposit was formed here, contemporary with the Capsize lithocap prospect and the Ortiz low sulfidation epithermal prospect.
The third and last recorded magmatic-hydrothermal event occurred at ~ 265 Ma. Only subvolcanic intrusions record this volcanic event, which produced lithocap alteration and low sulfidation epithermal mineralization (Herbert Creek East, Castle, Strathmoore, Boundary and Mt. Herbert).

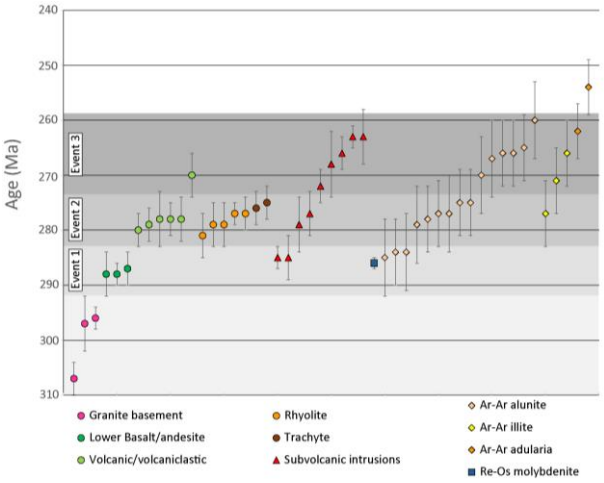

***Fig 2**. Geochronological chart of the Mt. Carlton district.*

REFERENCES

Champion, D.C., & Bultitude, R.J., (2013): Kennedy Igneous Association, in "Geology of Queensland", P.A. Jell, ed. Geological Survey of Queensland, p. 473–514.

Cross, A.J., Bultitude, R.J., and Purdy, D.J., (2012): Summary of results for the joint GSQ-GA geochronology project: Ayr, Bowen, Eulo, Mount Coolon, Proserpine and Warwick 1:250000. **2012/19**, Geological Survey of Queensland, Brisbane.

Donchak, P.J.T., Purdy, D.J., Withnall, I.W., Blake, P.R., and Jell, P.A., (2013): New England orogen, in "Geology of Queensland", P.A. Jell, ed. p. 305-427.

Henderson, R., (1980): Structural outline and summary of geological history for northeastern Australia, in "The geology and geophysics of northeastern Australia", R.A. Henderson and P.J. Stephenson, eds. Geological Society of Australia-Queensland Division, p. 1–26.

Korsch, R., Totterdell, J., Cathro, D., and Nicoll, M., (2009): Early Permian east Australian rift system. Aust. J. Earth Sci. **56**, 381–400. DOI: 10.1080/08120090802698703.

Malone, E.J., Corbett, D.W.P., and Jensen, A.R., (1964): Geology of the Mount Coolon 1:250000. **64**, Bureau of Mineral Resources, Australia, Canberra.

Sahlström, F., Dirks, P., Chang, Z., Arribas, A., Corral, I., Obiri-Yeboah, M., and Hall, C., (2018): The Mt. Carlton Deposit, Bowen Basin, NE Australia: Shallow High-Sulfidation Epithermal Au-Ag-Cu Mineralization Formed during Rifting. Econ. Geol. **113**, 1733-1767. DOI: 10.5382/econgeo.2018.4611.