CHARACTERISTICS OF PORPHYRY Au-Cu SYSTEMS IN THE ORDOVICIAN MACQUARIE ARC OF NSW

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Key Words: copper, gold, porphyry systems, Macquarie Arc, Ordovician

Abstract

The early Ordovician to early Silurian Macquarie arc of the Lachlan Orogen in NSW is Australia's only economic porphyry Cu-Au province. The province is currently host to six active mines with a further two deposits in feasibility stages. An additional seventeen significant porphyry systems exist within the Macquarie arc making a total of twenty five porphyry systems (Smith et al., 2003). In addition a further ten significant Cu and/or Au systems that may be porphyry-related in the broader sense exist (Table 1; Figure 1). Numerous other minor occurrences with porphyry or porphyry-related characteristics occur throughout the arc.

The deposits are not uniformly distributed throughout the volcanic belts and extreme clustering is evident at all scales. The location of the known systems is heavily skewed toward four productive districts. These districts occupy approximately 11% of the explored volcanic belts but contain 92% of the known systems. Two of the districts contain all of the known economic and feasibility stage systems. These districts can be distinguished to a certain extent from much of the remaining Macquarie arc, but no single or combination of features can definitively distinguish them.

The productive Porphyry Districts share many features (in addition to their mineral endowment) that distinguish them from much of the Macquarie arc. Importantly however these features do not uniquely define the productive districts because other areas have been identified that share some of the features but are not yet known to be productive.

One of the most critical and striking aspects of the districts is the abundance of intrusive rocks compared to the Macquarie arc outside the productive districts. The Cadia-Forest Reefs District as we define it has an area of 430 km2 and within this mapped intrusive rocks occupy 51 km2. Therefore approximately 12% of the total area of the Cadia Forest Reefs District is represented by intrusive rocks compared to 3.5% in the Molong Volcanic Belt as a whole.

The Ordovician volcanic belts display compositions ranging from ultramafic to felsic; however the dominant compositions are within the basalt to andesite range (Wyborn, 1992; Wyborn, 1997). Within the Porphyry Districts, compositions are relatively more felsic with a greater representation of andesitic and trachytic rocks.

The association between potassic magmas and mineralization in the Macquarie arc has been discussed by numerous workers (eg Muller et al., 1994; Holliday et al., 2002; Blevin, 2002). Blevin (2002) has highlighted that intrusives of the Goonumbla and Cadia Districts are more K-enriched than the intrusives of the Copper Hill area and supported an association between K-enrichment and mineralisation potential.

The variable K-enrichment is reflected in modal quartz contents with the less K-enriched rocks containing quartz at much lower SiO2 values than the more K-enriched magma suites (Blevin, 2002). Both of the isolated porphyry systems (Cargo and Copper Hill) are characterized by quartz-rich suites (Torrey & White, 1998, Blevin, 2002).

Insufficient published data exists to evaluate the K-enrichment of the other districts and the Macquarie arc as a whole; however it is likely that the intrusive chemistry and degree of enrichment could prove to be one of the most reliable discriminators of productive districts. Another feature of the intrusive rocks that helps distinguish the Porphyry Districts is their distinct

pink to brick red color due to fine hematite dusting. Although rocks of this color occur outside the productive districts, pink to red rocks are overrepresented in the districts.

The JNVB and MVB are highly magnetic and are easily identified on regional aeromagnetic data. However the character of the belts is not uniform and a number of complexes within the belts display anomalous character. All of the Porphyry Districts have the anomalous character; however several anomalous complexes exist that, to date, have not proven to be productive.

The anomalous complexes are characterized by highly complex magnetic signatures ranging from intense highs to deep lows and distinctly curvilinear to blocky patterns. We interpret these signatures to reflect a higher abundance of variably magnetic intrusive rocks and a greater degree of magnetite destructive and magnetite constructive alteration. In those parts of the arc outside the complexes the patterns are dominated by stratigraphic variations in magnetic character.

Gravity data helps to distinguish the Goonumbla and Lake Cowal Districts. Both occur within the major regional gravity high that underlies the JNVB but correspond in part with ovoid gravity lows apparent in published gravity data (Heithersay & Walshe, 1995). Modeling of the Goonumbla gravity data has been interpreted to indicate the presence of a zoned felsic intrusive complex at depth that was the source of the mineralizing porphyries (Clarke & Schmidt, 2001).

Large scale NW-trending cross-structures have been inferred to play a part in localizing K-enriched magmas and mineralization in the Lachlan Orogen (Glen & Walshe, 1999; Glen & Wyborn, 1997; Glen et al., 1998). The most commonly cited one (the Lachlan Transverse Zone) contains the Goonumbla and Cadia-Forest Reefs Districts. Definition of these structural zones is severely hampered by the effects of major post-Ordovician structural events and their applicability to exploration is limited.

The Macquarie arc porphyry Au-Cu systems represent a substantial exploration challenge in an area of increasing exploration maturity. Detailed exploration models that integrate the range of features of the significant systems will increase the probability of success

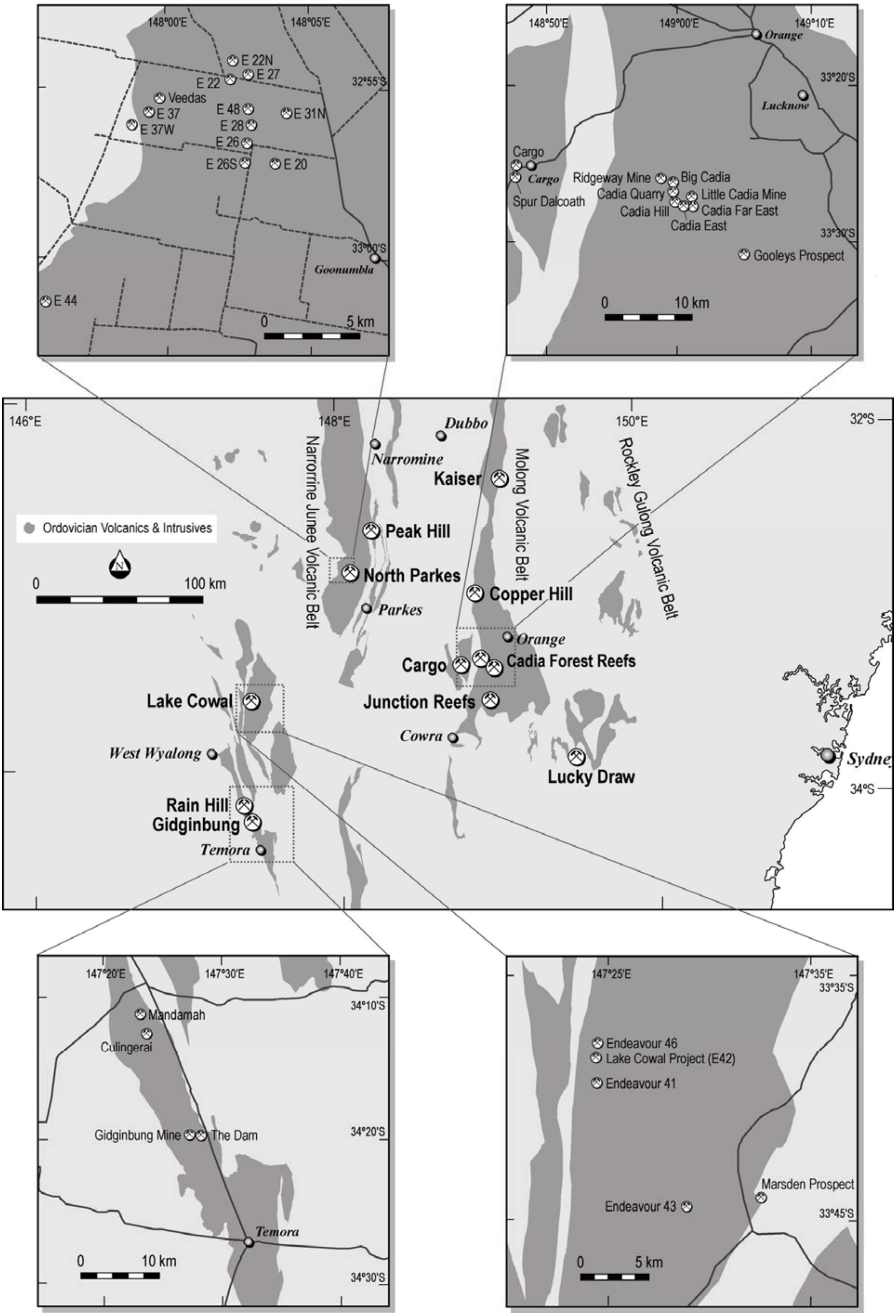

Figure1. Location of Macquarie arc porphyry and porphyry-related systems.

Table 1. Macquarie arc porphyry and porphyry-related systems

System	District	Style	Position of Magnetite	Status	Resources (Total Measured, Indicated and Inferred Resources and Reserves) or Intersections		
					Mt	Au (g/t)	Cu (%)
E26	Northparkes	Porphyry Cu-Au	Peripheral magnetite-bearing zone, overprinted	Mine	65.3	0.39	1.37
E22	Northparkes	Porphyry Cu-Au	Peripheral magnetite-bearing zone, overprinted	Mine	18.6	0.61	0.71
E27	Northparkes	Porphyry Cu-Au	Peripheral magnetite-bearing zone, overprinted	Mine	14.4	0.73	0.71
E48	Northparkes	Porphyry Cu-Au	Peripheral magnetite-bearing zone, overprinted	Mine	33.4	0.59	1.04
E37	Northparkes	Porphyry Cu-Au	Unknown	Inactive Prospect	6.8	0.02	0.66
E37W	Northparkes	Porphyry Cu-Au	Unknown	Inactive Prospect			
Veedas	Northparkes	Porphyry Cu-Au	Unknown	Inactive Prospect	102 m @ 0.47% Cu , Au <0.1 g/t		
E22North	Northparkes	Porphyry Cu-Au	Unknown	Inactive Prospect			
E20	Northparkes	Porphyry Cu-Au	Unknown	Inactive Prospect			
E31North	Northparkes	Porphyry Cu-Au	Unknown	Inactive Prospect	6.6	0.39	0.35
E26S	Northparkes	Porphyry Cu-Au	Unknown	Inactive Prospect			
E28	Northparkes	Porphyry Cu-Au	Unknown	Inactive Prospect			
E44	Northparkes	Magnetite Skarn	Unknown	Inactive Prospect			
Cadia Hill	Cadia-Forest Reefs	Porphyry Cu-Au	Widespread and unrelated to ore forming stage	Mine	352	0.63	0.16
Cadia Ridgeway	Cadia-Forest Reefs	Porphyry Cu-Au	Central and widespread peripheral	Mine	54	2.5	0.77
Cadia East	Cadia-Forest Reefs	Porphyry Cu-Au		Inactive Prospect	220	0.43	0.37
Cadia Far East	Cadia-Forest Reefs	Porphyry Cu-Au	Related to early weakly mineralised veins	Feasibility	63	1.7	0.48
Cadia Quarry	Cadia-Forest Reefs	Porphyry Cu-Au	Widespread and unrelated to ore forming stage	Active Prospect	40	0.4	0.21
Gooleys	Cadia-Forest Reefs	Porphyry Cu-Au		Active Prospect	44 m @ 1.3 g/t Au, 0.55% Cu		

Big Cadia	Cadia-Forest Reefs	Magnetite Skarn	Central	Former mine			
Little Cadia	Cadia-Forest Reefs	Magnetite Skarn	Central	Inactive Prospect			
Junction Reefs	Cadia-Forest Reefs	Pyrrhotite Skarn		Former Mine	247,500 ounces produced		
E43	Lake Cowal	Porphyry Cu-Au	Central and peripheral magnetite-bearing zone	Inactive Prospect	490 m @ 0.19% Cu		
Marsden	Lake Cowal	Porphyry Cu-Au		Inactive Prospect	123 m @ 0.63 g/t Au, 0.7% Cu		
E42	Lake Cowal	Carbonate -BM Au			69.9	1.5	
E41	Lake Cowal	Carbonate -BM Au					
E46	Lake Cowal	Carbonate -BM Au					
Mandamah	Rain Hill	Porphyry Cu-Au	Central magnetite-bearing zone	Inactive Prospect	206 m @ 0.51 g/t Au, 0.37% Cu		
Cullingarai	Rain Hill	Porphyry Cu-Au	Central magnetite-bearing zone	Inactive Prospect	50 m @ 0.76 g/t Au, 0.53% Cu		
The Dam	Rain Hill	Porphyry Cu-Au	Completely overprinted	Inactive Prospect	167 m @ 1.0 g/t Au, 0.7% Cu		
Gidginbung	Rain Hill	High-S epithermal		Former Mine	8.7	2.4	
Copper Hill		Porphyry Cu-Au		Active Prospect	6.6	0.8	0.8
Cargo	Cargo	Porphyry Cu-Au	Peripheral magnetite-bearing zone	Active Prospect	108 m @ 0.22 g/t Au, 0.52% Cu		
Cargo Area Au Systems (eg Spur Dalcoath)	Cargo	Quartz-sulphide Au		Inactive Prospect	3.7	1.24	
Peak Hill		High-S epithermal		Former Mine			

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