



Gold Mineralisation in the Adelaide Fold Belt

PhD thesis submitted by

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Declaration

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Abstract

This project provides an up to date study of the various types and occurrences of gold-(base metal) mineralisation in the Adelaide Fold Belt, South Australia. The Adelaide Fold Belt comprises Neoproterozoic to Cambrian sediments and igneous rocks and Mesoproterozoic basement inliers deformed and metamorphosed during the Delamerian Orogeny between 520 Ma and 490 Ma. A number of small primary gold-(base metal) mineralisations are known in the Fold Belt which have produced about 250,000 oz of gold since the middle of the 19th century. This study investigates the geological setting, the mineralogy, geochemistry, fluid characteristics, stable and radiogenic isotopes as well as the timing of these mineralisation in relation to the Delamerian Orogeny. Gold mineralisation in the Adelaide Fold Belt are dominantly sediment-hosted, structurally controlled mineralisation in host-rocks that underwent greenschist- to amphibolite facies metamorphism during the Delamerian Orogeny. The majority of mineralisations is hosted by a restricted section of the Neoproterozoic Adelaidean strata, the lower Umberatana Group. Gold in the investigated mineralisation is usually associated with base metals (Cu and, or Pb-Zn-Cd-Ag). Fluid inclusion studies show that mineralising fluids have moderate to high salinities. Fluid inclusion studies were combined with Titanium in Quartz geothermobarometry resulting in a T-P range of ore formation from 300 °C to 450 °C and 1.5 kbar to 5 kbar. Oxygen isotopes of hydrothermal quartz (+13.3 ‰ to +19.9 ‰) and carbonate (+10.8 ‰ to +30.6 ‰) indicate an metamorphic origin of fluids. Carbon isotopes of hydrothermal carbonate range from -10.2 ‰ to +1.4 ‰ and may be a result of a mixing of carbon from sedimentary carbonate and C_{org} . Sulphur isotope values in the investigated mineralisation range from +2 ‰ to +25 ‰ supporting a sedimentary sulphur source within the Adelaidean strata. Zn-isotope values of sphalerite from the Woodside goldfield range from -0.53 ‰ to +0.43 ‰ with the majority of values close to crustal average, indicating that most Zn from the source could be mobilised and that no fractionation took place between source and mineralisation. Pb isotopes of galena of the Woodside and Baratta mineral field are anomalous radiogenic and could represent a source within the Basement or the Adelaidean strata. Sr-isotopes of vein carbonate range from 0.710 to 0.719 and support a Sr source within the central to lower Adelaidean. Direct dating of mineralisation and the relationship of mineralisation to Delamerian igneous rocks show that mineralisation formed post-peak metamorphism in the extensional late stage of the Delamerian Orogeny or later. Most mineralisation have shown no links to magmatic activity. The general geological, structural and T-P characteristics support a classification of the investigated mineralisation as orogenic gold mineralisation but fluid chemistry and the base metal content of the mineralisation are unusual for these type of deposits. Some deposits in the central part of the Adelaide Fold Belt (Nackara Arc) also have characteristics of Telfer-style mineralisation.

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Contents

| | | |
|----------|---------------------------------------|-----------|
| 1 | Introduction | 1 |
| 1.1 | Geology of the Adelaide Fold Belt | 2 |
| 1.1.1 | Geography | 2 |
| 1.1.2 | Stratigraphy | 3 |
| 1.1.3 | Delamerian Orogeny | 10 |
| 1.2 | Mining and exploration history | 13 |
| 1.3 | Previous research | 17 |
| 1.4 | Gold mineralisation | 22 |
| 1.5 | Approach | 24 |
| 2 | Geology | 29 |
| 2.1 | Introduction | 30 |
| 2.2 | Woodside | 30 |
| 2.3 | Kitticoola, Palmer | 31 |
| 2.4 | Deloraine | 32 |
| 2.5 | Humbug Scrub Diggings/Lady Alice Mine | 33 |
| 2.6 | Mongolata area | 34 |
| 2.6.1 | Mongolata | 34 |
| 2.6.2 | Black Hill diggings | 36 |
| 2.7 | Mt. Grainger | 37 |
| 2.8 | Baratta | 38 |
| 3 | Ore characterisation | 41 |
| 3.1 | Introduction | 42 |
| 3.2 | Ore petrography | 42 |
| 3.2.1 | Woodside | 42 |
| 3.2.2 | Kitticoola | 49 |
| 3.2.3 | Lady Alice | 52 |
| 3.2.4 | Deloraine | 55 |
| 3.2.5 | Mongolata | 55 |
| 3.2.6 | Mt. Grainger | 60 |
| 3.2.7 | Baratta | 60 |
| 3.3 | EPMA | 64 |
| 3.3.1 | Methods | 64 |
| 3.3.2 | Results | 64 |
| 3.4 | Trace elements | 72 |
| 3.4.1 | Methods | 72 |
| 3.4.2 | Results | 73 |

| | | |
|----------|--------------------------------------|------------|
| 3.5 | Interpretation | 98 |
| 4 | Host rock geochemistry | 103 |
| 4.1 | Introduction | 104 |
| 4.2 | Methods | 104 |
| 4.2.1 | Whole rock analyses | 104 |
| 4.2.2 | Mineral separates | 105 |
| 4.2.3 | Micro spot analyses | 105 |
| 4.3 | Sediment geochemistry | 106 |
| 4.3.1 | Whole rock | 106 |
| 4.3.2 | Meta-sedimentary pyrite | 114 |
| 4.3.3 | Discussion | 119 |
| 4.4 | Woodside Dolerites | 120 |
| 4.4.1 | Geochemistry | 120 |
| 4.4.2 | EPMA tourmaline | 124 |
| 4.4.3 | Discussion | 126 |
| 5 | Fluid and metal source | 129 |
| 5.1 | Introduction | 130 |
| 5.2 | Fluid characterisation | 130 |
| 5.2.1 | Introduction | 130 |
| 5.2.2 | Fluid inclusion studies | 130 |
| 5.2.3 | Titanium in Quartz (TiQ) | 139 |
| 5.2.4 | Gethermobarometry | 140 |
| 5.2.5 | Chlorite Geothermometry | 145 |
| 5.2.6 | Discussion | 146 |
| 5.3 | Stable isotopes | 151 |
| 5.3.1 | Methods | 151 |
| 5.3.2 | Results | 153 |
| 5.3.3 | Discussion | 157 |
| 5.4 | Radiogenic isotopes | 168 |
| 5.4.1 | Methods | 168 |
| 5.4.2 | Results | 169 |
| 5.4.3 | Discussion | 170 |
| 6 | Timing | 177 |
| 6.1 | Introduction | 178 |
| 6.2 | Xenotime dating | 178 |
| 6.2.1 | Method | 178 |
| 6.2.2 | Results | 178 |
| 6.2.3 | Deloraine | 178 |
| 6.3 | Discussion | 179 |
| 7 | Interpretation and Conclusion | 183 |
| 7.1 | Interpretation | 184 |
| 7.2 | Conclusion | 189 |
| | References | 201 |

| | | |
|----------|-------------------------------------|------------|
| A | Mineralogy | 205 |
| A.1 | Woodside | 206 |
| A.1.1 | Bird In Hand | 206 |
| A.1.2 | Eureka | 213 |
| A.2 | Kitticoola | 217 |
| A.3 | Deloraine | 220 |
| B | Microprobe data | 223 |
| B.1 | Tourmaline | 224 |
| B.2 | Chlorite | 228 |
| B.3 | Carbonate | 232 |
| B.4 | Pyrite | 234 |
| B.5 | Pyrrhotite | 240 |
| B.6 | Sphalerite | 241 |
| B.7 | Native gold and electrum | 242 |
| B.8 | Arsenic minerals from Eureka | 244 |
| B.9 | Lady Alice mine | 245 |
| C | Sulphide LA-ICP-MS-data | 247 |
| C.1 | Concentrations | 248 |
| C.1.1 | Woodside | 248 |
| C.1.2 | Kitticoola | 259 |
| C.1.3 | Deloraine | 262 |
| C.1.4 | Mongolata area | 264 |
| C.1.5 | Mt. Grainger | 269 |
| C.1.6 | Baratta | 271 |
| C.1.7 | Lady Alice, Para Wirra | 273 |
| C.1.8 | McLaren Vale Quarry | 275 |
| D | Geochemical data | 277 |
| D.1 | Whole rock data | 278 |
| D.1.1 | Sample list | 278 |
| D.1.2 | Major element data | 279 |
| D.1.3 | Whole rock trace element data | 282 |
| D.1.4 | REE data | 286 |
| D.1.5 | Sequential leach data | 289 |
| D.2 | Tourmaline and carbonate | 298 |
| D.3 | Sulphides | 301 |
| D.3.1 | Pyrite | 301 |
| D.3.2 | Sphalerite | 302 |
| E | Fluid inclusion and TiQ data | 303 |
| E.1 | Fluid inclusion data | 304 |
| E.1.1 | Woodside goldfield | 304 |
| E.1.2 | Kitticoola, Palmer | 307 |
| E.1.3 | Mongolata | 308 |
| E.1.4 | Baratta | 308 |
| E.2 | TiQ data | 309 |
| E.2.1 | Woodside | 309 |

| | | |
|----------|------------------------------------------|------------|
| E.2.2 | Kitticoola, Palmer | 311 |
| E.2.3 | Deloraine | 312 |
| E.2.4 | Mongolata | 313 |
| E.2.5 | Baratta | 315 |
| F | Stable isotope data | 317 |
| F.1 | Carbon and oxygen isotope data | 318 |
| F.2 | Sulphur isotope data | 320 |
| F.3 | Zinc isotope data | 323 |
| G | Radiogenic Isotopes | 325 |
| G.1 | Pb isotope data | 326 |
| G.2 | Sr isotope data | 327 |
| H | U-Pb data | 329 |
| H.1 | Kitticoola data | 330 |
| H.2 | Deloraine data | 331 |

List of Figures

| | | |
|------|----------------------------------------------------------------------------------|----|
| 1.1 | Subareas of the Adelaide Fold Belt | 2 |
| 1.2 | The Adelaide Fold Belt in South Australia | 3 |
| 1.3 | Geological overview map | 5 |
| 1.4 | Stratigraphy of the Adelaidean | 6 |
| 1.5 | Saddleworth Formation | 7 |
| 1.6 | Tapley Hill Formation | 8 |
| 1.7 | Brighton Limestone | 8 |
| 1.8 | Cox Sandstone | 9 |
| 1.9 | Tarcowie Siltstone | 9 |
| 1.10 | Stratigraphy of the Cambrian Moralana Supergroup | 10 |
| 1.11 | Geological overview map of the Adelaide Fold Belt with major gold mineralisation | 14 |
| 1.12 | Types of hydrothermal gold deposits in orogenic belts | 23 |
| | | |
| 2.1 | Geological map of the Woodside goldfield | 30 |
| 2.2 | Geological map of the Palmer area including the Kitticoola mine | 32 |
| 2.3 | Geological map of the Deloraine and Humbug Scrub goldfield areas | 33 |
| 2.4 | Geology of the Mongolata area | 34 |
| 2.5 | Geology of the Mongolata Goldfield | 35 |
| 2.6 | Quartz-Fe veins at Byles open cut, Mongolata | 36 |
| 2.7 | Geological map of the Mt. Grainger Goldfield | 37 |
| 2.8 | Veining near Mt. Grainger Mine | 38 |
| 2.9 | Geological map of the Baratta mineral field | 38 |
| 2.10 | Veining at Baratta, Saltbush Flat | 39 |
| | | |
| 3.1 | Mineralogy of Bird In Hand, Woodside goldfield | 43 |
| 3.2 | Mineralogy of Bird In Hand, Woodside goldfield | 44 |
| 3.3 | Mineralogy of Bird In Hand, Woodside goldfield | 45 |
| 3.4 | Mineralogy of Eureka, Woodside goldfield | 48 |
| 3.5 | Mineralogy of Kitticoola, Palmer | 50 |
| 3.6 | Mineralogy of Kitticoola, Palmer | 51 |
| 3.7 | Mineralogy of the Lady Alice Mine | 53 |
| 3.8 | Mineralogy of the Lady Alice Mine | 54 |
| 3.9 | Mineralogy of Deloraine | 56 |
| 3.10 | Mineralogy of the Mongolata goldfield | 57 |
| 3.11 | Mineralogy of the Mongolata goldfield | 58 |
| 3.12 | Mineralogy of Mongolata Black Hill Diggings and Mt. Grainger goldfield | 61 |
| 3.13 | Mineralogy of Baratta Eukaby Hill | 62 |
| 3.14 | Mineralogy of Baratta Saltbush Flat | 63 |
| 3.15 | FeO-CaO-MgO plot of microprobe analyses of hydrothermal carbonate | 64 |

| | | |
|------|-----------------------------------------------------------------------------------------------------------------------------|-----|
| 3.16 | Ag concentration in native gold / electrum | 66 |
| 3.17 | Boxplot of Fe and Cd microprobe concentration in sphalerite | 70 |
| 3.18 | SEM/BSE image of LA spot 1d, BH20-2 | 74 |
| 3.19 | Time resolved LA-ICP-MS intensity plot of pyrite in sample BH20-2, point 1d | 75 |
| 3.20 | Time resolved LA-ICP-MS intensity plot of pyrite in sample BH20-2, point p2 | 76 |
| 3.22 | Zonation of a pyrite crystal in section Mon-2 | 79 |
| 3.23 | Time resolved LA-ICP-MS intensity plot of pyrite in sample BSB004, point 1e | 81 |
| 3.24 | Time resolved LA-ICP-MS intensity plot of pyrite in sample BSB004, point 2b | 82 |
| 3.25 | Co vs Ni of LA-ICP-MS and solution ICP-MS data of pyrite of gold mineralisation and metasediments | 83 |
| 3.26 | As vs Co+Ni LA-ICP-MS data of pyrite of gold mineralisation and metasediments | 83 |
| 3.27 | As vs Co/Ni LA-ICP-MS and solution ICP-MS data of pyrite of gold mineralisation and metasediments | 84 |
| 3.28 | As vs Se LA-ICP-MS and solution ICP-MS data of pyrite of gold mineralisation and metasediments | 84 |
| 3.41 | Concentration biplots of LA-ICP-MS and solutions ICP-MS data of sphalerite from the Woodside goldfield | 91 |
| 3.42 | Concentration biplots of LA-ICP-MS and solutions ICP-MS data of sphalerite from the Woodside goldfield | 92 |
| 3.43 | Time resolved LA-ICP-MS intensity plot of galena in sample BH01, point g1 | 93 |
| 3.44 | Time resolved LA-ICP-MS intensity plot of galena in sample BH20-2, point g1 | 94 |
| 3.45 | Time resolved LA-ICP-MS intensity plot of galena in sample BH20-2, point g2 | 95 |
| 3.46 | Concentration biplots of LA-ICP-MS concentration data of galena from Bird In Hand, Eureka and Baratta Eukaby Hill | 97 |
| 3.47 | Summarised mineralogy of the Woodside Goldfield | 100 |
| 3.49 | Summarised mineralogy of the Deloraine mineralisation | 101 |
| 3.48 | Summarised mineralogy of the Kitticoola mineralisation | 101 |
| 4.1 | Tapley Hill Formation | 106 |
| 4.2 | Major elements vs upper crust plot of lower Umberatana Group sediments | 109 |
| 4.3 | Trace elements vs upper crust plot of lower Umberatana Group sediments | 110 |
| 4.4 | REE vs upper crust plot of lower Umberatana Group sediments | 111 |
| 4.5 | Sample LW-1, Linwood Quarry: Availability of various elements during sequential leaching | 112 |
| 4.6 | Sample LW-2, Linwood Quarry: Availability of various elements during sequential leaching | 112 |
| 4.7 | Sample MVQ-4, McLaren Vale Quarry: Availability of various elements during sequential leaching | 112 |
| 4.8 | Sample MVQ-5, McLaren Vale Quarry: Availability of various elements during sequential leaching | 112 |
| 4.9 | Sample TH-1, Mongolata: Availability of various elements during sequential leaching | 112 |
| 4.10 | Sample TS-7, Mongolata: Availability of various elements during sequential leaching | 112 |
| 4.11 | Sample Mon-15u, Mongolata: Availability of various elements during sequential leaching | 113 |
| 4.12 | Average availability of various elements during sequential leaching | 113 |
| 4.13 | Co/Ni ratios changes in sequential leach of Tarcowie Siltstone and Tapley Hill Formation samples | 113 |
| 4.14 | Sample TH-2, Drilling PCD001 Mongolata | 114 |

| | | |
|------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 4.15 | Pyrite in sample Mon-15u, Byles Mine, Mongolata | 114 |
| 4.16 | Pyrite in sample MVQ-5, McLaren Vale Quarry | 115 |
| 4.17 | As vs Au count per second data for Tarcowie Siltstone and Tapley Hill Formation pyrite | 117 |
| 4.18 | Cu vs Se count per second data for Tarcowie Siltstone and Tapley Hill Formation pyrite | 117 |
| 4.19 | As vs Au count per second data for Tarcowie Siltstone and Tapley Hill Formation pyrite | 117 |
| 4.20 | Cu vs Se count per second data for Tarcowie Siltstone and Tapley Hill Formation pyrite | 117 |
| 4.21 | As vs Au count per second data for Tarcowie Siltstone and Tapley Hill Formation pyrite | 118 |
| 4.22 | Cu vs Se count per second data for Tarcowie Siltstone and Tapley Hill Formation pyrite | 118 |
| 4.23 | TAS diagram of Woodside Dolerite samples | 120 |
| 4.24 | Woodside Dolerite vs primitive mantle | 121 |
| 4.25 | REE data for sequential leach of altered Woodside Dolerite | 121 |
| 4.26 | REE data for sequential leach of altered Woodside Dolerite | 122 |
| 4.27 | Isocon diagramm for altered/unaltered Woodside Dolerite | 122 |
| 4.28 | Tourmaline REE vs chondrite plot | 123 |
| 4.29 | Chondrite normalised REE plot of alteration carbonate from Woodside Dolerite . | 123 |
| 4.30 | Chondrite normalised REE plot of vein carbonate | 123 |
| 4.31 | Scans of section BH19-AD2 (left) and BH22-AD2 (right) . Tourmaline appears brown-green, chloritised dolerite appears olive green, sulphides are black and calcite veins appear white. | 124 |
| 4.32 | BSE image of a tourmaline cross section in sample BH22-AD2. Tourmaline occurs in a chlorite matrix (white). It shows internal zoning with brighter parts being type I tourmaline and darker parts being type II tourmaline. | 124 |
| 4.33 | Microprobe crosssection of tourmaline | 125 |
| 4.34 | Fe/(Fe+Mg) vs Na/(Na+Ca) plot of tourmaline | 125 |
| 5.1 | Fluid inclusion in quartz of sample BH02, Bird In Hand, Woodside | 131 |
| 5.2 | Fluid inclusion in quartz of sample BH02, Bird In Hand, Woodside | 131 |
| 5.3 | Fluid inclusion in quartz of sample KD04-2, Kitticoola mine, Palmer | 132 |
| 5.4 | Type I fluid inclusion in quartz of sample MC-6, Mongolata | 132 |
| 5.5 | Fluid inclusion in quartz of sample BEH006, Eukaby Hill, Baratta | 133 |
| 5.6 | Fluid inclusion data of Bird In Hand and Eureka, Woodside: Histogram of salinity | 134 |
| 5.7 | Fluid inclusion data of Bird In Hand and Eureka, Woodside: Histogram of TT_{hvap} | 134 |
| 5.8 | Fluid inclusion data of Bird In Hand and Eureka, Woodside: Salinity vs T_{hvap} . | 135 |
| 5.9 | Fluid inclusion data of Kitticoola mine, Palmer: Histogram of salinity | 135 |
| 5.10 | Fluid inclusion data of Kitticoola mine, Palmer: Histogram of T_{hvap} | 136 |
| 5.11 | Fluid inclusion data of Kitticoola mine, Palmer vs T_{hvap} | 136 |
| 5.12 | P-T diagram for combined fluid inclusion and TiQ data, Woodside goldfield. . . . | 141 |
| 5.13 | P-T diagram for combined fluid inclusion and TiQ data of Kitticoola, Mongolata and Baratta. | 141 |
| 5.14 | T-P diagram for fluid inclusion (FI) and Titanium-in-Quartz (TiQ) data for sections from Bird In Hand and Eureka, Woodside | 142 |

| | | |
|------|------------------------------------------------------------------------------------------------------------------------------------------|-----|
| 5.15 | T-P diagram for fluid inclusion (FI) and Titanium-in-Quartz (TiQ) data for sections Eureka, Woodside, and Kitticoola, Palmer | 143 |
| 5.16 | T-P diagram for fluid inclusion (FI) and Titanium-in-Quartz (TiQ) data for sections from Mongolata and Baratta | 144 |
| 5.17 | Al^{IV} vs $Fe/(Fe+Mg+Mn)$ diagram of chlorite | 145 |
| 5.18 | Chlorite geothermometer temperatures for Bird In Hand and Kitticoola | 147 |
| 5.19 | $\delta^{66}Zn$ histogram of samples from the Woodside goldfield | 155 |
| 5.20 | $^{68}Zn/^{64}R''$ vs $^{66}Zn/^{64}R'$ plots for uncorrected data | 156 |
| 5.21 | Corrected $\delta^{68}Zn$ vs $\delta^{68}Zn$ plot | 156 |
| 5.22 | $\delta^{18}O_{quartz}$ and $\delta^{18}O_{carbonate}$ in comparison to rocks in the Mt. Lofty Ranges | 157 |
| 5.23 | T vs $\delta^{18}O_{H_2O}$ for vein quartz, calculated using quartz-H ₂ O fractionation calibration of Zheng (1993) | 158 |
| 5.24 | $\delta^{18}O$ vs $\delta^{13}C$ plot for carbonate | 158 |
| 5.25 | $\delta^{18}O_{Fluid}$ for investigated and other gold mineralisation and reservoirs | 159 |
| 5.26 | T vs $\delta^{18}C_{CO_2}$ diagram for Kitticoola ankerite and Kanmantoo Group marbles | 160 |
| 5.27 | Sulphur isotope distribution in gold mineralisation of the Adelaide Fold Belt | 161 |
| 5.28 | T vs $\delta^{34}S_{H_2S}$ diagram for Woodside sulphides | 162 |
| 5.29 | T vs $\delta^{34}S_{H_2S}$ diagram for Kitticoola sulphides | 162 |
| 5.30 | T vs $\delta^{34}S_{H_2S}$ diagram for Baratta Eukaby Hill sulphides | 163 |
| 5.31 | T vs $\delta^{34}S_{\sum S}$ diagram for Kitticoola | 163 |
| 5.32 | Sulphur isotope range of Adelaidean strata and mineralisation | 163 |
| 5.33 | Pb-Pb isotope data of mineralisation in the Adelaide Fold Belt | 169 |
| 5.34 | $^{87}Rb/^{86}Sr$ vs $^{87}Sr/^{86}Sr$ plot for tourmaline and calcite from Bird In Hand | 170 |
| 5.35 | Sr-isotope data for tourmaline and carbonate of investigated mineralisation and Adelaidean host sediments | 174 |
| 6.1 | Idiomorphic xenotime used for U-Pb dating, sample KD1-640Bt, Kitticoola | 178 |
| 6.2 | U-Pb isochron for Kitticoola xenotime, sample KD1-640Bt, Kitticoola | 179 |
| 6.3 | Idiomorphic xenotime used for U-Pb dating, sample De001, Deloraine | 179 |
| 6.4 | U-Pb isochron for Deloraine xenotime, sample De001, Deloraine | 179 |
| 6.5 | Timing of Delamerian Orogeny, magmatism and mineralisation | 182 |
| 7.1 | Summary map of gold mineralisation in the Adelaide Fold Belt | 185 |
| 7.2 | Evolution of the Delamerian Orogen in South Australia and timing of Au-mineralisation | 189 |

List of Tables

| | | |
|-----|-----------------------------------------------------------------------------------------------------------------------------|-----|
| 1.1 | Goldfields of the Adelaide Fold Belt | 16 |
| 3.1 | Summarised microprobe data of hydrothermal carbonate | 65 |
| 3.2 | Summarised microprobe data for native gold and electrum | 67 |
| 3.3 | Summarised microprobe data of pyrite | 69 |
| 3.4 | Summarised microprobe data for arsenopyrite, gersdorffite and tennantite | 71 |
| 3.5 | Summarised LA-ICP-data for various gold mineralisation | 86 |
| 3.6 | Summarised sphalerite LA-ICP-MS data, Woodside | 96 |
| 3.7 | Summary of mineralogy and pyrite geochemistry of investigated mineralisation in the Adelaide Fold Belt | 99 |
| 4.1 | Summarised data of Tapley Hill and Tarcowie Siltstone samples | 108 |
| 4.2 | Summarised LA-ICP-data for sedimentary pyrite | 116 |
| 4.3 | Summary of tourmaline microprobe data of altered Woodside Dolerite, Bird In Hand, Woodside | 126 |
| 5.1 | Summary of primary fluid inclusion data, Woodside goldfield | 133 |
| 5.2 | Summary of primary fluid inclusion data, Kitticoola mine, Palmer | 135 |
| 5.3 | Summarised fluid inclusion data of quartz from gold bearing quartz veins in the Adelaide Fold Belt | 138 |
| 5.4 | Fluid inclusion and TiQ isochor input data and P-T results for Woodside, Kitticoola, Mongolata and Baratta quartz | 149 |
| 5.5 | Summarised microprobe data of chlorite | 150 |
| 5.6 | Summarised $\delta^{18}\text{O}$ data of vein quartz | 153 |
| 5.7 | Summary of $\delta^{18}\text{O}$ and $\delta^{13}\text{C}_{PDB}$ data of carbonate | 153 |
| 5.8 | Summary of $\delta^{34}\text{S}$ data of gold mineralisation in the Adelaide Fold Belt | 154 |
| 5.9 | Rb-Sr data for investigated tourmaline and calcite from Bird In Hand, Woodside | 171 |
| 6.1 | Ages of mineralisation in the Adelaide Fold Belt | 182 |