Appendix 1: U-Pb LA-ICP-MS zircon dating – analytical methodology

Mineral separations were done at the Pacific Centre for Isotopic and Geochemical Research (PCIGR) at the University of British Columbia, using conventional crushing, pulverizing, and wet shaking table concentration methods, followed by heavy liquid and magnetic separation.

Uranium-lead analyses were carried out using laser ablation (LA) ICP-MS methods. Analyses were done using a New Wave UP-213 laser ablation system and a ThermoFinnigan Element2 single collector, double-focusing, magnetic sector ICP-MS. The data acquisition and reduction protocol employed at the PCIGR has been described by Tafti et al. (2009), and is briefly summarized below. The best quality zircons were handpicked from the heavy mineral concentrate and mounted in an epoxy puck along with several grains of the 337 Ma Plešovice zircon standard (Sláma et al., 2007) and a 197 Ma in-house zircon monitor, and brought to a very high polish. The surface of the mount was washed for 10 minutes with dilute nitric acid and rinsed in ultraclean water prior to analysis. High quality portions of each grain, free of alteration, inclusions, or cores, were selected for analysis. Line scans rather than spot analyses were employed in order to minimize elemental fractionation during the analyses (Košler et al., 2008). Backgrounds were measured with the laser shutter closed for ten seconds, followed by data collection with the laser firing for approximately 29 seconds. The time-resolved signals were analyzed using GLITTER software (Van Achterbergh et al., 2001; Griffin et al., 2008), which automatically subtracts background measurements, propagates all analytical errors, and calculates isotopic ratios and ages. Corrections for mass and elemental fractionation were made by bracketing analyses of unknown grains with replicate analyses of the Plešovice zircon standard.

A typical analytical session at the PCIGR consists of four analyses of the standard zircon, followed by two analyses of the 197 Ma in-house zircon monitor, four analyses of unknown zircons, two standard analyses, four unknown analyses, etc., and finally two analyses of the in-house monitor and four standard analyses. Final interpretation and plotting of the analytical results employs ISOPLOT software (Ludwig, 2003). The amount of radiogenic ^{207}Pb in young zircons is extremely low; hence, counting errors are correspondingly high, and calculated errors for $^{207}Pb/^{235}U$ and $^{207}Pb/^{206}Pb$ ages are also high. Interpreted ages for the samples dating in this study are based on a weighted average of the individual calculated $^{206}Pb/^{238}U$ ages. The amount of measured ^{204}Pb in all but a very small number of the analyses generated during the study is negligible, so no correction was made for contained common Pb.

References cited

Griffin, W.L., Powell, W.J., Pearson, N.J. and O'Reilly, S.Y., 2008, Glitter: Data reduction software for laser ablation ICP-MS; *In* Sylvester, P.J. (ed.), Laser Ablation ICP-MS in the Earth Sciences: Current Practices and Outstanding Issues, Mineralogical Association of Canada Short Course Series, Short Course 40, Vancouver, B.C., pp. 308-311.

Košler, J., Forst, L., Sláma, J., 2008, Lamdate and Lamtool: spreadsheet-based data reduction for laser ablation ICP-MS; *In* Sylvester, P.J. (ed.), Laser Ablation ICP-MS in the Earth Sciences: Current Practices and Outstanding Issues, Mineralogical Association of Canada Short Course Series, Short Course 40, Vancouver, B.C., pp. 315-317.

Ludwig, K., 2003, Isoplot/Ex, version 3: A geochronological toolkit for Microsoft Excel: Berkeley, California, Geochronology Center, Berkeley.

Sláma, J., J., Košler, J., Condon, D.J. Crowley, J.L., Gerdes, A., Hanchar, J.M., Horstwood, M.S.A., Morris, G.A., Nasdala, N., Norberg, N., Schaltegger, U., Schoene, B., Tubrett, M.N. and Whitehouse, M.J., 2007, Plešovice zircon — A new natural reference material for U–Pb and Hf isotopic microanalysis, Chemical Geology, v. 249, pp. 1-35.

Tafti, R., Mortensen, J.K., Lang, J.R., Rebagliati, M. and Oliver, J.L., 2009, Jurassic U-Pb and Re-Os ages for newly discovered Xietongmen Cu-Au porphyry district, Tibet: Implications for metallogenic epochs in the southern Gangdese Belt; Economic Geology, v. 104, pp. 127–136

Van Achterbergh, E., Ryan, C.G., Jackson, S.E. and Griffin, W.L., 2001, Data reduction software for LA-ICP-MS: appendix; *In* Sylvester, P.J. (ed.), Laser Ablation –ICP-Mass Spectrometry in the Earth Sciences: Principles and Applications, Mineralogical Association of Canada Short Course Series, Ottawa, Ontario, Canada, v. 29, pp. 239-243.