Regional Isotopic Survey Systematics: deciphering the fluid-flow variations along deformation zones in Superior Province

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INTRODUCTION

The Regional Isotopic Survey Systematics (RISS) is part of a Metal Earth thematic project, which focuses on the characterization through time and space of the auriferous fluid-flow system(s) as 'source-to-sink' systems. The objective of the RISS is to characterize the spatial variation of auriferous fluid flows and their isotopic composition (O, C, H, S) along the main deformation zones where the orogenic gold deposits are localized. Indeed, the general orogenic gold model of fluid circulation consists in the circulation of auriferous fluid along a major lithospheric-scale shear zone and in the connected anastomosed network of lower-order shear zones, in which orogenic gold deposits occur (Robert et al., 1995, 2005). This spatial distribution of gold deposits could suggest that spatial variation of fluid-flow and related variation of fluid–rock interaction are important parameters in their formation.

The first aim of the project consists in testing this hypothesis by comparing the variation of auriferous-fluid isotopic composition along, and in close proximity to, targeted deformation zones located in Abitibi (endowed end-member) and in Wabigoon (less-endowed end-member). The second step will consist in modelling, using a reactive-transport model (Beaudoin et al., 2006), the interaction of the auriferous fluids with hostrocks along targeted shear zones and in the anastomosed network of secondary shear zones. By modelling the kinetics of the oxygen stable-isotope exchange between the circulating fluid and the hostrocks, the fluid-flow pattern required to reproduce the spatial variation of the oxygen isotopic composition of documented fluids can be determined. The work will be focused along the Cadillac–Larder Lake deformation zone (CLLDZ), which is an ideal geologically constrained area. Numerous stable isotopic values of orogenic veins are available from the literature for this area, in which a complementary field season is planned next summer.

STRATEGY

The strategy adopted follows that of the Metal Earth research initiative, which consists of comparing endowed and less-endowed areas at various scales.

Two field seasons (2018 and 2019) were dedicated to the sampling of orogenic quartz±carbonate-tourmaline veins within the main shear zones occurring along Metal Earth transects in the Abitibi and Wabigoon subprovinces. Approximately 240 orogenic veins were sampled along the Chibougamau, Malartic, Rouyn-Noranda, Larder Lake, Geraldton and Dryden transects (Figure 1 and Table 1), and the analysis of stable isotopic compositions (H, C, O) of constituent minerals are currently in progress. The results will help determine if significant spatial variation of stable isotopic composition can be identified for orogenic minerals and related fluids between the Wabigoon and the Abitibi subprovinces.

The second part of the project consists in building a georeferenced database of stable isotopic values compiling data from the literature and new data acquired during this project. To date, approximately 900 and 450 stable-isotope data entries (O, C, H, S) from the literature have been georeferenced for the Abitibi and the Wabigoon areas, respectively (Figure 1). This georeferenced database will allow to visualize spatial variation of the stable isotopic composition of orogenic minerals and related fluids as a function of the geology. This map will be used 1) to build the simplified 3D geological model showing the circulation of the auriferous fluids and their interaction with hostrocks, and 2) to identify the areas where additional sampling is required.

FUTURE WORK

Results from stable isotopic analysis of samples collected in 2018 and 2019 are expected early in 2020. Data will then be processed and integrated into the georeferenced dataset and will be used to build the simplified 3D geological model showing the interaction of the auriferous fluids with hostrocks along the CLLDZ. Additional sampling is planned for summer 2020 to complete the sampling grid along the CLLDZ, at those locations where gaps in the data have been identified.

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FIGURES

Table 1. Samples collected during the 2018 and 2019 field seasons along different Metal Earth transects. The category 'Other' includes chlorite, epidote and mica minerals.

	Chibougamau	Malartic	Rouyn-Noranda	Larder Lake	Geraldton	Dryden	Total
Number of veins	41	28	67	36	36	36	244
Quartz	40	31	63	33	37	35	239
Carbonate	1	3	19	16	11	8	58
Tourmaline	15	6	3	2	2	9	37
Other	4	2	0	0	0	3	9
Total samples	60	42	85	51	50	55	343

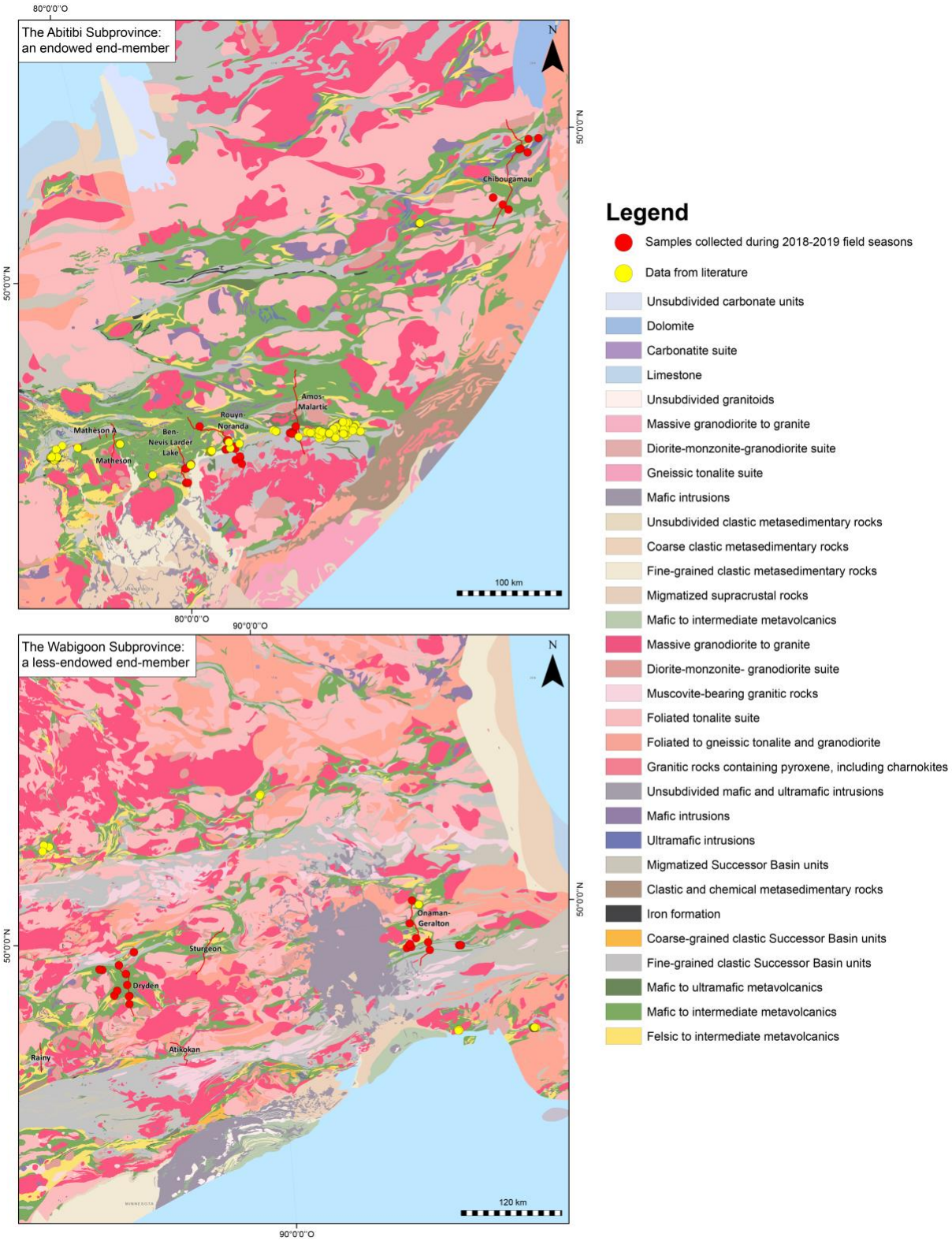

Figure 1. Location of orogenic vein samples collected during the 2018 and 2019 field seasons and of data from the literature. Geology of the Superior Province *modified from* Montsion et al. (2018).