Current Research (2003) Newfoundland Department of Mines and Energy Geological Survey, Report 03-1, pages 47-50

A NOTE ON THE U–Pb ZIRCON AGE OF THE WOODFORD'S ARM GRANITE, AND ITS RELATIONSHIP TO THE ROBERTS ARM GROUP, CENTRAL NEWFOUNDLAND (NTS 2E/12)

A. Kerr and G.R. Dunning[1]
Mineral Deposits Section

ABSTRACT

This note summarizes a U–Pb zircon age from the Woodford's Arm granite, which intrudes the calc-alkaline portion of the Roberts Arm Group in central Newfoundland. The age of the granite (472 ± 4 Ma) is within error of an earlier 473 ± 3 Ma age obtained from a rhyolite, within the calc-alkaline portion of the Roberts Arm Group. This suggests that the Woodford's Arm granite is a coeval and possibly subvolcanic pluton. Relationships between the granite and an adjacent fault zone, coupled with regional relationships, provide some general constraints upon the timing of deformation of the Roberts Arm Group.

INTRODUCTION

This note presents, and briefly discusses, a U–Pb zircon age acquired in 1996, in conjunction with mapping in the Roberts Arm Group (Kerr, 1996). The only previous reference to U–Pb ages from this project is in a Geological Association of Canada (Newfoundland Section) field trip guide (Kerr and Thurlow, 1996), which is no longer widely available.

GEOLOGICAL FRAMEWORK AND PREVIOUS GEOCHRONOLOGY

The Roberts Arm Group was mapped in detail by Bostock (1988), and stratigraphic and structural relationships were partly revised by Kerr (1996), who divided it into five "terranes", separated by variably steepened, southeast-dipping thrust faults. The structurally lowermost terrane (Boot Harbour terrane) is dominated by calc-alkaline basalts, but also contains well-preserved felsic submarine volcanic rocks. It also includes a broadly "conformable" granitic pluton, called the Woodford's Arm granite, which appears to have hornfelsed adjacent basaltic rocks. A second pluton, the Loon Pond granite, occurs in the Boot Harbour terrane south of Highway 370 (Bostock, 1988; O'Brien, *this volume*). Early Rb–Sr geochronological studies in the Roberts Arm Group indicated ages of 447 ± 7 Ma for the volcanic rocks and 464 ± 13 Ma for the Woodford's Arm granite, previously called the "Sunday Cove pluton" (Bostock *et al.*, 1979). Field relationships (*see above*) indicate that the granite intrudes the volcanic rocks, but the two ages are within error of one another, and they were considered to be coeval. Dunning *et al.* (1987) subsequently obtained a more precise U–Pb zircon age of 473 ± 2 Ma for a "rhyolite" from the Roberts Arm Group, collected near to the community of Roberts Arm.

U–Pb GEOCHRONOLOGY

The Woodford's Arm granite was dated to test the notion that it is a subvolcanic pluton, and also because it appears to be truncated by the Sunday Cove–Bear Cove fault zone, which separates the Boot Harbour terrane from the adjacent Mud Pond terrane. The sample was analyzed following procedures described elsewhere (e.g., Dunning *et al.*, 1990) and the analytical results are listed in Table 1.

The sample was collected on the west shore of Woodford's Arm, a short distance from Highway 371, which leads from Robert's Arm to Sunday Cove Island. The outcrop (location: UTM 580320E 5484170N; NTS 2E/12) is about 50 m north of the trace of the Sunday Cove–Bear Cove fault zone, which separates the granite, from hematitic, deformed pillow lavas of the adjacent Mud Pond terrane. This fault zone defines the southern boundary of the Woodford's Arm granite for several kilometres, indicating that important fault motions postdate its intrusion. Intense brittle fracturing is common in the granite adjacent to the fault trace in inland

[1] Department of Earth Sciences, Memorial University of Newfoundland, St. John's, Newfoundland, Canada, A1B 3X5

Table 1. U–Pb isotopic data for the Woodford's Arm granite

	CONCENTRATIONS				CORRECTED ISOTOPIC RATIOS					ISOTOPIC AGES (Ma)		
Fraction Number	Weight (mg)	U (ppm)	Pb (rad) (ppm)	Pb (comm) (pg)	$^{206}Pb/^{204}Pb$	$^{208}Pb/^{206}Pb$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$
Z1	0.02	657	57.8	10	6280	0.3104	0.07477 ± 58	0.58200 ± 40	0.05645 ± 24	465	466	470
Z2	0.02	610	53.6	5	8691	0.3045	0.07492 ± 34	0.58370 ± 26	0.05651 ± 12	466	467	472

Notes

Pb (rad) : Radiogenic Pb
Pb (comm) : Total common Pb

Isotopic ratios corrected for fractionation, spike, laboratory blank of 2-10 pg of common lead, and initial common lead at the age of the sample calculated from the model of Stacey and Kramers (1975) and 1 pg of uranium blank. Two sigma uncertainties are reported after the ratios and refer to the final digits.

areas, and the granite is cut by schistose chloritic zones on the east shore of Woodford's Arm, adjacent to the fault trace. Irregular, vein-like zones of recrystallized granite and felsite occur also within the fault zone near the sample site, where they are generally concordant with a strong schistosity. However, the contacts of these granitic veins appear to be locally discordant to this fabric. The fault zone and the granitic veins both exhibit strong iron carbonate alteration, and it is therefore difficult to be certain if these granitic veins are directly equivalent to the adjacent Woodford's Arm granite.

In thin section, the sample is a fairly simple equigranular rock, consisting mostly of quartz, plagioclase and K-feldspar. It appears to be a monzogranite or granite (*s.s.*) based on modal proportions. The dominant mafic mineral is chlorite, but the chlorite aggregates appear to pseudomorph original igneous hornblende. No sign of deformation or significant recrystallization was observed.

Two fractions of high-quality small, euhedral, prismatic zircons, both abraded, have $^{207}Pb/^{206}Pb$ ages of 471 and 472.9 Ma (Table 1) and overlap the concordia curve, but are ca. 1.3% discordant (Figure 1). The crystallization age is interpreted to be 472 ± 4 Ma, based on the weighted average of the $^{207}Pb/^{206}Pb$ ages (uncertainty at 95% confidence interval).

DISCUSSION

The U–Pb age from the Woodford's Arm granite (472 ± 4 Ma) is within error of the 473 ± 3 Ma age previously reported by Dunning *et al.* (1987) for the Roberts Arm Group. Assuming that the latter age indeed comes from a volcanic or pyroclastic unit (*see below*), this is consistent with the idea that the Woodford's Arm granite is a coeval pluton that formed an integral part of the Roberts Arm Group volcanic sequence (Bostock *et al.*, 1979). The hornfelsing of basaltic rocks adjacent to the pluton, and the presence of numerous felsitic dykes stratigraphically above it (Bostock, 1988; Kerr, 1996) suggest that it could have fed at least some overlying felsic volcanic rocks.

The U–Pb zircon ages provide information regarding motions on the Sunday Cove–Bear Cove fault zone and (by inference) analogous structures that separate the various terranes of the Roberts Arm Group. The age indicates that important motion must postdate 472 ± 4 Ma. The Middle Silurian Springdale Group sits unconformably on three separate terranes of the Roberts Arm Group (Kerr, 1996), indicating that the Roberts Arm Group was deformed prior to 427 Ma (the age of a Springdale Group rhyolite dated by Chandler *et al.*, 1987). However, the basal unconformity is vertical to upside-down in most places, which indicates sig-

nificant Silurian or post-Silurian deformation, likely accompanied by reactivation of the fault zone. The deformed fine-grained granitoid rocks within the Sunday Cove–Bear Cove fault zone may further constrain the timing of earliest deformation, because these appear to locally cut the fabric in the fault zone (Kerr, 1996). If these granitic veins are equivalent to the adjacent granite, this implies that the earliest deformational events took place before 472 ± 4 Ma, suggesting that the time interval between formation and first deformation of the Roberts Arm Group was very short, and below the effective resolution of U–Pb geochronology. There are thus at least two, and possibly three, episodes of motion upon this fault zone.

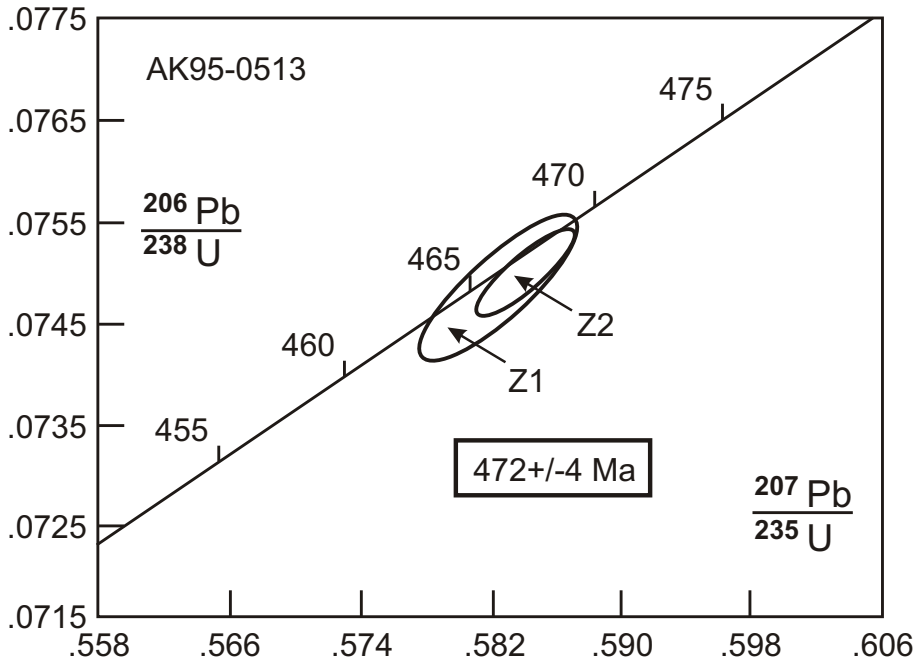

Figure 1. *U–Pb concordia diagram for the Woodford's Arm granite.*

However, it is important to note that part of the above discussion assumes that the generally accepted age for the Roberts Arm Group (473 ± 3 Ma; Dunning *et al*., 1987) indeed represents a volcanic unit. Attempts in 1996 to date two other samples considered to be of definite volcanic origin were unsuccessful, due to a lack of zircon. Also, hypabyssal plutonic rocks that superficially resemble flows are widespread in many parts of the Roberts Arm Group (Kerr, 1996), and these might correlate with the Woodford's Arm granite. Re-examination suggests that felsic outcrops in the vicinity of the Dunning *et al*. (1987) sample site are of unclear origin. Thus, the possibility that the Roberts Arm Group is older than 473 ± 3 Ma cannot be ruled out.

ACKNOWLEDGMENTS

The U–Pb geochronology was funded by the Canada–Newfoundland Agreement on Mineral Development (1994-96). Steve Colman-Sadd is thanked for reviewing the manuscript and suggesting improvements.

REFERENCES

Bostock, H.H.
1988: Geology and petrochemistry of the Ordovician volcano-plutonic Robert's Arm Group, Notre Dame Bay, Newfoundland. Geological Survey of Canada, Bulletin 369, 84 pages.

Bostock, H.H., Currie, K.L. and Wanless, R.K.
1979: The age of the Robert's Arm Group, north-central Newfoundland. Canadian Journal of Earth Sciences, Volume 16, pages 599-606.

Chandler, F.W., Sullivan, R.W. and Currie, K.L.
1987: Age of the Springdale Group, western Newfoundland - Evidence for a Llandovery overlap assemblage in the Canadian Appalachians. Transactions of the Royal Society of Edinburgh, Earth Sciences, Volume 78, pages 41-49.

Dunning, G.R., Kean, B.F., Thurlow, J.G. and Swinden, H.S.
1987: Geochronology of the Buchans, Roberts Arm and Victoria Lake Groups, and the Mansfield Cove Complex, Newfoundland. Canadian Journal of Earth Sciences, Volume 24, pages 1175-1184.

Dunning, G.R., Barr, S.M., Raeside, R.P. and Jamieson, R.A.
1990: U–Pb zircon, titanite and monazite ages in the Bras d'Or and Aspy terranes of Cape Breton Island, Nova Scotia: Implications for igneous and metamorphic history. Geological Society of America Bulletin, Volume 102, pages 322-330.

Kerr, A.
1996: New perspectives on the stratigraphy, volcanology and structure of Ordovician island-arc volcanic rocks in the Roberts Arm Group, Notre Dame Bay. *In*

Current Research. Newfoundland Department of Natural Resources, Geological Survey Branch, Report 96-1, pages 283-311.

Kerr, A. and Thurlow, J.G.
1996: The Roberts Arm Group in Notre Dame Bay: New ideas on stratigraphy, structure and mineralization. Geological Association of Canada (Newfoundland Section), Autumn Field Trip 1996, 22 pages.

O'Brien, B.H.
This volume: Internal and external relationships of the Ordovician Roberts Arm Group in part of the Springdale (NTS 12H/8) map area, west-central Newfoundland.

Stacey, J.S. and Kramers, J.D.
1975: Approximation of terrestrial lead isotope evolution by a two-stage model. Earth and Planetary Science Letters, Volume 26, pages 207-221.