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THE TIMING OF TECTONOTHERMAL EVENTS AND THE HISTORY OF TERRANE ACCRETION WITHIN THE CADOMIAN OROGEN, WESTERN FRANCE

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The evolution of the Cadomian Orogen, within the Armorican Massif of western France and the Channel Islands, has been interpreted in terms of the amalgamation of calc-alkaline magmatic-arc complexes, and associated intra-arc and marginal basin complexes, at an active plate boundary along the northern margin of a Gondwana supercontinent (Strachan et al., 1989, 1991). Magmatism and accretionary tectonism in the Cadomian Orogen spanned the period c. 700-475 Ma (Dallmeyer et al., 1991a, b, c, d). The North Armorican Shear Zone (NASZ) separates Cadomian elements of the North Armorican Composite Terrane (NACT) from the Variscan Central Armorican Terrane. The NACT comprises four terranes which are separated by steep ductile shear zones and brittle faults. From north to south these include the arc-related Tregor-La Hague (TLHT) and St. Brieuc (SBT) Terranes, which are separated by the sinistral strike-slip Fresnaye Shear Zone from the behind-arc St. Malo (SMT) and Mancellian (MT) Terranes (Figure 1). $^{40}Ar/^{39}Ar$ mineral cooling ages (Dallmeyer et al., 1991, a, b, c, d), in combination with U-Pb zircon and monazite ages, indicate a complex and polyphase Cadomian tectonothermal evolution. Recorded tectonothermal events within each terrane are listed, with references, in Table 1.

Within the TLHT deformed quartz diorites within an early arc suite record U-Pb zircon ages which may suggest crystallization at c. 700 Ma. Hornblende $^{40}Ar/^{39}Ar$ mineral cooling ages of c. 600 Ma for these rocks and amphibolitic hosts are interpreted to date post-peak metamorphic cooling

following deformation and metamorphism of the arc system. By contrast, within the SBT U-Pb zircon ages suggest crystallization of calc-alkaline complexes in the interval c. 670-650 Ma and at c. 600-590 Ma. $^{40}Ar/^{39}Ar$ mineral cooling ages of 570-565 Ma from a late- to post-tectonic quartz diorite intrusion and from metamorphosed supracrustal rocks indicate that the post-peak metamorphic cooling which followed transpressive deformation was significantly younger in the SBT than in the TLHT to the north.

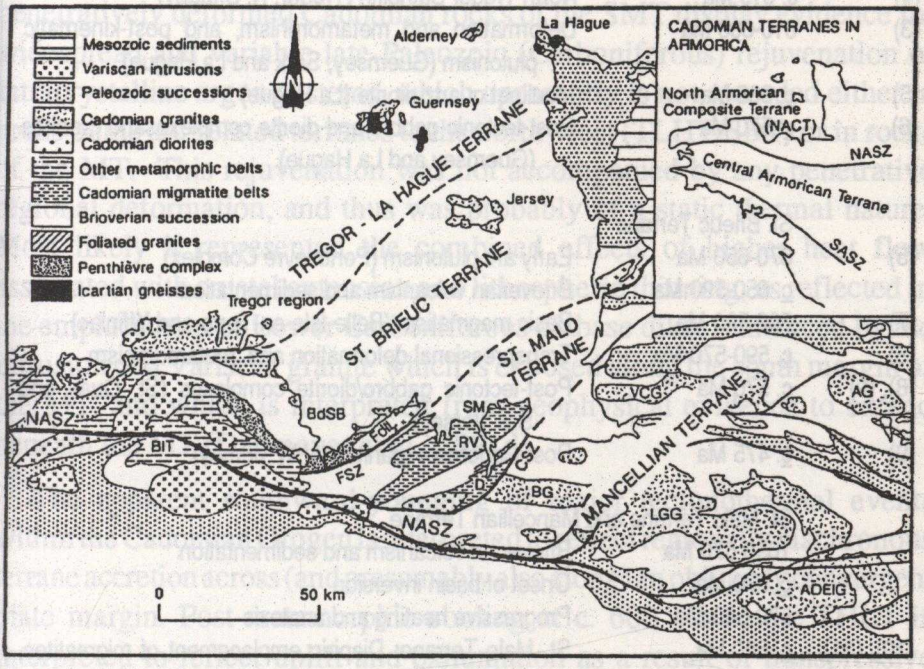

Fig. 1: Provisional terrane and simplified geologic map of the North Armorican Massif (modified from Strachan et al., 1989). NASZ = North Armorican Shear Zone; SASZ = South Armorican Shear Zone; VCG = Vire Carolles Granite Complex; AG = Athis Granite Complex; ADEIG = Alexain-Deux Evailles-Ize Granite Complex; LGG = Louvigne-Gorron Granite Complex; BG = Bonnemain Granite Complex; CSZ = Cancale Shear Zone; D= Dinan; RV= Rance Valley; SM = St. Malo; FSZ = Fresnaye Shear Zone; FdlL = Fort de la Latte Intrusion; BdSB = Baie de St. Brieuc; BIT = Belle-Isle-en-Terre.

Both of these arc-related terranes contrast with the SMT and the MT, which are characterized by migmatites derived by anatexis of the marginal basin succession (SMT) and intracrustally derived granitic plutons emplaced into the marginal basin sequence (MT) (Brown and D'Lemos, 1991;

TABLE 1

Events within constituent terranes of the North Armorican Composite Terrane, Cadomian Orogen, West France

Reference		Event / Unit
	Tregor-La Hague Terrane	
(1), (2)	2000-1800 Ma	Icartian basement
(3)	c. 700 Ma	Early arc plutonism (Guernsey)
(4)	c. 615 Ma	North Tregor Batholith (Tregor, N. Brittany)
(3)	610-600 Ma	Deformation and metamorphism, and post-kinematic plutonism (Guernsey, Sark and La Hague)
(5)	c. 585 Ma	Moulinet quartz diorite (La Hague)
(6)	c. 570 Ma	Post-tectonic gabbro and diorite complexesand granites (Guernsey and La Hague)
	St. Brieuc Terrane	
(5)	670-650 Ma	Early arc plutonism (Penthievre Complex)
	c. 650-590 Ma	Brioverian volcanism and sedimentation
(7)	600-590 Ma	Basic magmatism (Belle-Isle-en-Terre and Yffiniac)
(8)	c. 590-570 Ma	Transpressional deformation and metamorphism
(8), (9)	c. 570 Ma	Post-tectonic gabbro/diorite complexes (St. Quay and S.E. Jersey)
(9)	c. 475 Ma	Post-Cadomian granites (N.W. Jersey)
	St. Malo Terrane and Mancellian Terrane	
	?650-570 Ma	Brioverian volcanism and sedimentation
	c. 570 Ma	Onset of basin inversion
	570-540 Ma	Progressive heating and anatexis
(10), (11)	c. 540 Ma	St. Malo Terrane: Diapiric emplacement of migmatites, transpressional deformation and synkinematic emplacement of anatectic granites into sinistral shear zones. Mancellian Terrane: Emplacement of Mancellian granites into a sinistral strikeslip extensional duplex
(12)	c. 525 Ma	Muscovite cooling ages (Bonnemain Granit Complex, Mancellian Terrane)
(12)	330-320 Ma	Reheating by sub-surface Variscan granite (St. Malo Terrane)
(12)	330-290 Ma	Reworking of granites along North Armorican Shear Zone

(1) Calvez & Vidal (1978): U-Pb zircon; (2) Auvray et al. (1980): U-Pb zircon; (3) Dallmeyer et al. (1991a): U-Pb zircon; (4) Graviou et al. (1988): U-Pb zircon; (5) Guerrot & Peucat (1990): U-Pb zircon; (6) Dallmeyer et al. (1991c): $^{40}Ar/^{39}Ar$ hornblende; (7) Peucat et al. (1981): U-Pb zircon; (8) Dallmeyer et al. (1991b): $^{40}Ar/^{39}Ar$ hornblende, muscovite; (9) Dallmeyer (unpublished data): $^{40}Ar/^{39}Ar$ hornblende; (10) Peucat (1986): U-Pb zircon, monazite; Rb-Sr whole-rock isochron; (11) Pasteels & Dore (1982): U-Pb monazite; (12) Dallmeyer et al. (1991d): $^{40}Ar/^{39}Ar$ muscovite.

D'Lemos and Brown, 1992). U-Pb zircon and monazite and Rb-Sr whole rock ages of c. 540 Ma have been reported from anatectic granite of the SMT, and similar monazite ages have been reported from the Vire Carolles Granite Complex of the MT. Muscovite within the Bonnemain Granite Complex (MT) records $^{40}Ar/^{39}Ar$ mineral cooling of c. 525 Ma, which is interpreted to date post-magmatic cooling. Emplacement of anatectic granites at c. 540 Ma in the SMT likely accompanied regional sinistral transpression, and amalgamation of the TLHT/SBT with the SMT and MT (Strachan et al., 1989, 1991). $^{40}Ar/^{39}Ar$ release spectra for muscovites from penetratively deformed Cadomian rocks of the SMT display evidence for widespread and variable late Paleozoic (Carboniferous) rejuvenation of intracrystalline argon systems, which apparently is not recorded either in rocks of the arc-related terranes to the north-west (TLHT/SBT) or in rocks of the MT. This rejuvenation was not accompanied by any penetrative regional deformation, and thus was probably of a static thermal nature. Most likely it represented the combined effects of higher heat flow associated with crustal extension and lithospheric thinning, as reflected in the emplacement of Lower Carboniferous diabase dikes, enhanced by the intrusion of a Variscan granite which is exposed along the south margin of the MT, and which is interpreted from geophysical evidence to extend beneath the MT (Dallmeyer et al., 1991d).

The apparent southward-younging of major tectonothermal events within the Cadomian Orogen is interpreted to reflect regionally diachronous terrane accretion across (and presumably also along) an obliquely convergent plate margin. Post-metamorphic cooling at c. 600 Ma in the THLT is interpreted to reflect uplift and exhumation as a result of transpressive docking with the SBT. Similarly, post-metamorphic cooling at c. 570-565 Ma in the SBT is thought to reflect uplift and exhumation due to transpressive docking of the THLT/SBT composite terrane with the behind-arc basin, now represented by the SMT/MT composite terrane. The TLHT and SBT have a common post-tectonic magmatic history interpreted to reflect stitching plutonism at c. 570 Ma. Accretion of the TLHT/SBT composite terrane also most likely caused basin inversion in the SMT/MT (Brown and D'Lemos, 1991). Peak anatexis in the SMT/MT at c. 540 Ma apparently was coeval with continued or renewed regional sinistral transpression and terminal longitudinal assembly of the TLHT/SBT composite terrane with the SMT/MT composite terrane. Structural, petrographic, geochemical and isotopic evidence suggest that the SMT and MT may represent

different levels of a single tectonic unit (Brown and D'Lemos, 1991; D'Lemos and Brown, 1992). Absence of evidence of major crustal over-thickening during the Cadomian Orogeny implies that the orogenic activity did not culminate in continent-continent collision. This is consistent with the interpretation of the Cadomian Orogen as a peripheral orogen located at the margin of a late-Precambrian supercontinent following its amalgamation.

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