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Conveners:
Teixeira Wilson, Wilde Simon A.

241-1 Key Lecture Valley, John

CRUSTAL EVOLUTION AND MATURATION IN THE PRECAMBRIAN: OXYGEN ISOTOPE EVIDENCE

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Keywords: zircon; oxygen isotopes; evolution of crust; age; igneous

Zircon provides the most reliable record of magmatic oxygen isotope ratio as well as U-Pb age if significant radiation damage is avoided. No other mineral permits δ18-O(magma) to be confidently determined and coupled to age of crystallization (see Valley 2003 Rev. Mineral. Geochem. v. 53). Igneous zircons of known age (3.6 Ga to 0.2 Ma) have been analyzed for δ18-O by laser fluorination at the University of Wisconsin from over 1100 rocks worldwide. In addition to laser analyses of zircon concentrates (1-3 mg), single detrital zircons (4.4 to 3.0 Ga) from the Jack Hills, Western Australia were analyzed in situ (30 micron spot, ~2 ng) by ion microprobe. The range and variability of δ18-O in all Archean samples is subdued (δ18-O(Zrc)=5 to 7.5‰). Most samples have δ 18-O= 5-6.5‰, consistent with high temperature equilibrium with mantle values (Zc=5.3±0.3‰) or mildly evolved composition. No magmatic zircons have been analyzed from the Archean with "S-type" values (δ18-O above 8‰). This includes samples from Superior Province (3.0 - 2.7 Ga), Lewisian (2.7 Ga), Slave Province (2.7 Ga), and Barberton (3.5 to 2.7 Ga). Zircons analyzed by ion microprobe from the Jack Hills are indistinguishable in δ18-O from other Archean samples, including oldest zircon (4.4Ga); the highest values (7.4‰) are interpreted to result from exchange of pre-magmatic protolith with surface water. Values of δ18-O(Zc) from the Proterozoic and Phanerozoic are significantly more variable. Many zircons are above 8‰ showing that magmas with δ18-O(WR) > 9-10‰ became common only after ~1.5 Ga. The increased variability of the oxygen isotope ratios of intermediate to felsic magmas occurs in the Middle Proterozoic. Since fractionation of oxygen isotopes to values higher than the mantle requires low temperatures where fractionation is large, the greater variability in δ18-O must reflect recycling of supracrustal lithologies and progressive maturation of the crust. The dominant sources of high-δ18-O are sediments, and rocks weathered or altered by surface waters at low temperatures. Clearly such protoliths have increasingly been involved in genesis of younger magmas.

241-2 Oral Davies, Geoffrey Frederick

DYNAMICS OF THE ARCHEAN MANTLE, WITH GEOCHEMICAL AND TECTONIC IMPLICATIONS

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Keywords: episodic tectonics; dynamical segregation; magmatic outbursts; early mantle depletion

The inferred higher temperature of the mantle during the Archean may have given rise to tectonic styles and geochemical mechanisms significantly different from those of the Phanerozoic Earth ? plate tectonics may not have been viable, tectonics may have been much more episodic, and dynamical segregation of compositional components may have been substantial.Higher degrees of melting over mantle upwellings would produce thicker mafic crust than the present oceanic crust. At the same time, the lower viscosity would mean faster mantle flow, which would limit the thickness and negative thermal buoyancy of nascent plates. Together, these effects may have prevented viable plate tectonics. Mafic crust would have tended to accumulate over mantle downwellings, and may have foundered episodically or catastrophically as its deeper parts transformed to denser eclogite.Episodic mantle overturns caused by transition zone phase transformations would also have been more likely, but uncertainties in the relevant parameters are large enough to leave this possibility still conjectural.Numerical models of the present mantle indicate there is a small but significant tendency for denser eclogitic components to settle to the bottom, and this has been proposed both as an explanation for the D?? zone at the base of the mantle and as a possible source of the heterogeneous chemical signatures of mantle plumes.These numerical models have been extended to the conditions of the Archean mantle, and the settling of eclogitic components is found to be substantially greater. This could explain the strong incompatible-element depletion of the earliest mantle, which otherwise seems incompatible with the apparent absence of contemporaneous continental crust. If the settled mafic component formed a persistent layer, this could have led to one or more outbursts of magmatism.

241-3 Oral Castaing, Christian

PALEOPROTEROZOIC CRUSTAL EVOLUTION IN BURKINA FASO (WEST AFRICAN CRATON)

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Keywords: Paleoproterozoic; Eburnean; Birimian; Burkina Faso; Geodynamic evolution

Our knowledge of Burkina Faso has improved as result of the recent SYSMIN Project that included geological mapping, 60 datings and geochemical data. The dominant Paleoproterozoic basement, comprises belts of Birimian volcano-sedimentary rock intruded by batholiths of Eburnean granitoid. The evolution of this basement can be broken down into 3 major phases that partly overlap in time. The first phase corresponds to the emplacement of basaltic to felsic volcanics, sediments and gabbros making up the Birimian belts. The "oceanic" (depleted) affinity of the volcanism, indicates an initiation of Birimian crustal accretion away from any continental influence. This rules out the concept of an older pre-Birimian migmatitic basement and is supported by geochronological determinations. The first phase would have ended with the emplacement of andesitic-basaltic island-arc systems (ca 2240-2170 Ma). The second phase (2210-2100 Ma) corresponds to the almost continuous intrusion of a vast tonalite suite into the Birimian belts. The geochemical characteristics of this suite are similar to those of recent subduction-zone calc-alkaline rocks; their dominant adakitic signature indicates an origin through partial melting of subducted mafic rock. The third phase (2150-2095 Ma) corresponds to the emplacement of a granite suite and the inception of major NNE-trending sinistral shear zones. The granite suite is more acid and potassic than the tonalite suite, although some granites also exhibit an adakitic signature. The commonly high-K composition requires a "non-depleted" source material that is distinct from ocean-floor material -a "central Andean" type model with the genesis of potassic adakite through deep melting of an overthickened continental margin could be envisaged. Late alkaline granite and syenite (1889-1819 Ma) is found in a few dispersed bodies. The structural evolution of the Eburnean orogeny (2150-2095 Ma) was controlled by strike-slip shear zones that accommodated the regional shortening as well as active subduction. Two major NNE-trending sinistral shear zones cross the country and enabled lateral accretion and the collage of segments of juvenile crust made up of remnant bodies of basaltic crust, associated sediments and considerable masses of tonalite and granite. The finite strain exhibited by the basement rock resulted from both the regional stress regime (NW-SE shortening) and local stress regimes induced by the shearing and by the intrusion of the plutons.

241-4 Oral Gorbatschev, Roland

THE BIRTH OF ANCIENT EUROPE

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Keywords: Precambrian; East European Craton; Palaeoproterozoic; crustal accretion

In general outline, the continent of Europe consists of two distinct halves meeting each other along a boundary between the North and the Black Seas. While the northeastern half, the East European Craton (EEC), consisits of ancient, thick, cool and stable crust, the crust in the southwest, is younger, mostly thinner, and generally warmer. It was formed dominantly by a sequence of orogenies extending from the Cadomian to the Alpine. In contrast, the crust in the northeast is mostly older than 1500 Ma, the exceptions being restricted to relatively narrow marginal belts in the east (the Uralides), the north (the Timanides) and the northwest (the Sveconorwegian orogen). The overall model is thus one of an ancient core in the northeast, surrounded by later foldbelts which in the southwest and south expand into a series of stepwise younger, partly overlapping growth rims.The core of Europe itself, however, has not been there from the beginning of time. Rather it was formed in the latter half of the Palaeoproterozoic by a series of subduction processes. Some of these led to the collision and merger of three major crustal segments of dominantly Archaean crust, while others primarily resulted in the formation of juvenile Proterozoic crust from the EarthÖs mantle. Amongst the three colliding crustal segments, Sarmatia docked with Volgo-Uralia between c. 2.1 and 2.05 Ga, while resulting Volgo-Sarmatia subsequently joined Fennoscandia around 1.7 Ga. Thus the birth of ancient Europe occurred between 2.1 and 1.7 Ga. The global processes of which that birth was part did apparently involve the formation of a late Palaeoproterozoic supercontinent comprising both the European Precambrian craton and Laurentia as well as other proto-continents.Accretionary growth of juvenile Proterozoic continental crust not associated with the collision of major continental masses commenced outwards from Archaean Sarmatia and Fennoscandia already before these two crustal segments had joined each other. After the formation of the resultant EEC, it continued outwards from that proto-craton until approximately 1.5 Ga. The following Precambrian Danopolonian (c. 1.4-1.5 Ga) and Sveconorwegian-Grenvillian (c. 1.1-0.9 Ga) orogenies were, however, essentially collisional in Europe

241-5 Oral Halls, Henry

BROAD-SCALE PROTEROZOIC DEFORMATION OF THE ARCHEAN SUPERIOR PROVINCE, CANADA, AS GIVEN BY PALEOMAGNETISM OF CROSS-CUTTING DYKE SWARMS

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Keywords: Proterozoic; dyke swarms; paleomagnetism; Archean craton

The eastern and western halves of the Archean Superior Province of Canada are separated by the Kapuskasing Structural Zone,a zone of early Proterozoic faulting and crustal uplift, at least 500 km long and less than 50 km wide. Dyke swarms of two distinct ages (the 2.45 Ga Matachewan and 2.17 Ga Biscotasing) are found on both sides of this zone, and paleomagnetic studies on them suggest that the western half of the shield has rotated counterclockwise with respect to the eastern by about ten to fifteen degrees(Halls & Davis, 2003). It is hypothesized that the rotation accompanied deformation along the Kapuskasing Zone, and led to the opening of a ~2 Ga rift that might explain the pronounced embayment in the Superior Province that underlies Hudson bay. New paleomagnetic data will be presented from the extreme western part of the Matachewan swarm to test if the counterclockwise rotation increases westwards from the Kapuskasing zone. Reference: Halls, H.C. & Davis, D.W. Canadian Journal of Earth Sciences, Volume for March, 2004.

241-6 Oral Kotov, Alexander

ISOTOPE GEOLOGY AND PRECAMBRIAN GEODYNAMIC EVOLUTION OF THE ALDAN SHIELD (SIBERIA)

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Keywords: Aldan shield; isotope geology; geodynamic evolution

To the moment the Aldan Shield is an isotopically better-studied fragment of the Siberian Craton basement. Wide set of geochronological, isotopic and geochemical data allow us to make next conclusions on the Precambrian history of the region. (1) The main large-scale structures of the Chara-Olekma geoblock have been formed during of the Late Archaean - Early Proterozoic time however the structures of the Aldan and Batomga geoblocks relate to the Early Proterozoic time. (2)Protholites of the high-grade metamorphic rocks of the Aldan granulite-gneiss megacomplex were formed mainly at the Early Proterozoic. (3)Metavolcanic and metasedimentary rocks of greenstone belts of the Aldan shield belong to the four age groups generated at 2.0-2.4, 2.5-2.6, 2.6-3.0 and 3.0-3.2 Ga.(4)Growth of the Aldan shield continental crust during of the Precambrian occurred episodically and the main crust-forming events happened at 2.0-2.2, 2.9-3.0, 3.2-3.3 and 3.5-3.8 Ga.Proposed geodynamic model implies occurrence of two major accretional event at 2.76-3.01 and