Remnants of an Archean oceanic plateau, Belingwe greenstone belt, Zimbabwe

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ABSTRACT

Stratigraphic and structural data from the Archean Zimbabwe craton suggest that a major detachment surface exists within the Belingwe greenstone belt. The surface separates ultramafic and mafic magmatic rocks of the upper greenstones in the hanging wall from an ancient gneiss complex, older volcanic-sedimentary rocks, and a shallow-water sedimentary sequence in the footwall. Rocks dated at ca. 2.7 Ga above the detachment surface form the proposed Mberengwa allochthon. The regionally extensive upper greenstone succession represents tectonically emplaced allochthonous sheets, not indigenous magmas erupted within autochthonous continental rifts. Magmatic rocks of the Mberengwa allochthon resemble oceanic plateaus preserved in younger mountain belts. Comparison of the Zimbabwe craton with the Proterozoic Birrimian terranes of west Africa leads us to suggest that Precambrian continental growth may have been characterized by intense structural imbrication related to the difficulty of subduction of buoyant oceanic lithosphere.

INTRODUCTION

Controversy surrounding the tectonic setting of some of Earth's oldest rocks has stemmed from uncertainty about basic field relations between Archean greenstone belts and structurally underlying quartzofeldspathic gneiss complexes (Condie, 1981; de Wit and Ashwal, 1986; Glover and Ho, 1990). One group of models places the original tectonic environment of greenstone belt volcanic and sedimentary rocks in continental rifts, in unconformable contact with underlying gneiss (McKenzie et al., 1980; Bickle and Eriksson, 1982; Nisbet, 1987). Other models claim that greenstone belts are allochthonous remnants of accreted oceanic crust, oceanic plateaus, and island-arc material (de Wit, 1982; Sleep and Windley, 1982; de Wit et al., 1987; Hoffman, 1991; Kusky, 1989, 1990). A hybrid model allows unconformable contacts between gneiss and greenstone within an island-arc setting (Burke et al., 1976; Tarney et al., 1976; de Wit and Stern, 1981; Helmstaedt et al., 1986; Hoffman, 1991). Rarely, it seems, are "original" contact relations preserved between greenstone and gneiss, but nearly everywhere these contacts are faulted.

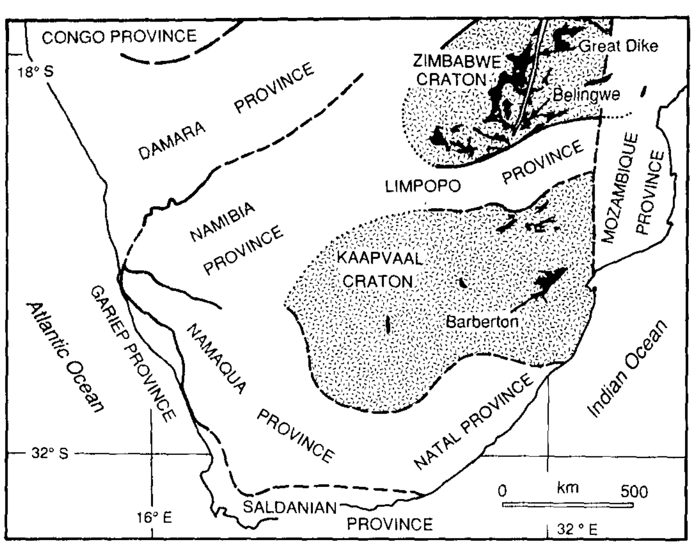

Figure 1. Tectonic elements of southern Africa showing location of *Belingwe greenstone belt in Zimbabwe craton (modified from Tankard* et al., 1982). Black indicates other Archean greenstone belt remnants (including Barberton).

Four cases have been repeatedly cited where field relations are interpreted to indicate that Archean greenstone belts were deposited unconformably over older gneiss: Steep Rock Lake in the Superior province of southern Canada (Wilks and Nisbet, 1988), Point Lake and Cameron River in the Slave province of northern Canada (Henderson, 1981) and, perhaps most important, Belingwe, Zimbabwe (Bickle et al., 1975; Nisbet et al., 1977; Nisbet, 1987). Structural relations at Steep Rock Lake can alternatively be interpreted to indicate a faulted contact between greenstone and underlying sedimentary rocks deposited unconformably over gneiss (Hoffman, 1989a, 1991). The "type unconformity" localities in the Slave province have recently been shown to contain faults with a minimum of tens of kilometres of slip between the greenstone and the underlying shallow-water sedimentary rocks and gneiss (Hoffman, 1989a; Kusky, 1990, 1991a). We suggest here that large displacements between greenstones and underlying shallow-water sedimentary rocks are concealed in a thin detachment surface within the Belingwe greenstone belt. The tectonic break is detectable by analysis of regional stratigraphic and structural relations (Kidd et al., 1988; Kusky, 1991b), and fault rocks and mylonites have been locally documented along the critical contact (Bickle et al., 1975; Martin, 1978; E. Nisbet, 1989, personal commun.).

GEOLOGY OF THE BELINGWE GREENSTONE BELT

The Belingwe greenstone belt is located in the southern Zimbabwe (formerly Rhodesian) craton, north of the Limpopo high-grade province and east of the Great Dike (Fig. 1). It contains the ca. 2.9 Ga lower greenstones and the ca. 2.7 Ga upper greenstones (Wilson et al., 1978). The greenstone belt has a refolded synformal outcrop pattern and is cut by several late faults (Fig. 2). The southern border is marked by the ca. 2.6 Ga Chibi batholith (Wilson et al., 1990), and similar late granitic rocks of the Chilimanzi Suite intrude the northern part of the belt, cutting out lower levels of the structural succession. The lower greenstones are intruded by ca. 2.9–2.8 Ga granitoids on the western margin of the synform (Wilson et al., 1990), but these rocks are older than the upper greenstones and are included in the basement gneiss complex for purposes of this paper (Fig. 2). The metamorphic grade of the upper greenstones is astonishingly low, with abundant fresh olivine, clinopryoxene, feldspar, and rare orthopyroxene, in the mafic and ultramafic rocks (Martin, 1978). Where encountered, serpentinization is attributed to weathering, and metamorphic mineral growth in the sedimentary rocks is restricted to the growth of sericite and chlorite (Martin, 1978).

Bickle et al. (1975), Martin (1978), and Nisbet (1987) described the stratigraphy of the Belingwe greenstone belt (Fig. 3). The "basement," or rocks upon which the greenstone belt rests, consists of many different units, including 2.9 and 3.6 Ga quartzofeldspathic gneiss, metapelitic gneiss, and mafic intrusions, all of which were deformed and metamorphosed prior to deposition of overlying sedimentary rocks (Wilson, 1979). These gneisses are overlain unconformably by a ca. 2.9 Ga "lower greenstone assemblage" (Mtshingwe Group) consisting of mafic, ultramafic, intermediate, and felsic volcanic rocks, pyroclastic deposits, and a variety of sedimentary rocks (Wilson, 1979, 1981). The lower unconformity at the base of the Mtshingwe Group is well exposed in at least six locations (T. Blenkinsop, 1990, personal commun.; J. M. Tsomondo, 1990, personal commun.).

A second well-exposed unconformity separates the "lower greenstones" from the Manjeri Formation, which previous workers included as the base of the ca. 2.7 Ga "upper greenstone succession," or Ngezi Group (MacGregor, 1951; Martin, 1978; Wilson, 1979, 1981). The base of the Manjeri Formation, which immediately overlies this unconformity, is marked by basal conglomerates and beach sandstones. These grade upward into a sequence of shallow-water sedimentary rocks exhibiting tidal structures and a remarkable group of stromatolitic limestones with well-preserved evidence of early life (Bickle et al., 1975; Martin et al., 1980; Abell et al., 1985; Grotzinger, 1989). Upper parts of the Manjeri Formation grade upward into distinctly different deep-water sedimentary rocks, including 5–10 m of chert and nearly 70 m of graded arenaceous and argillaceous beds, interpreted as turbidites. These deep-water deposits are

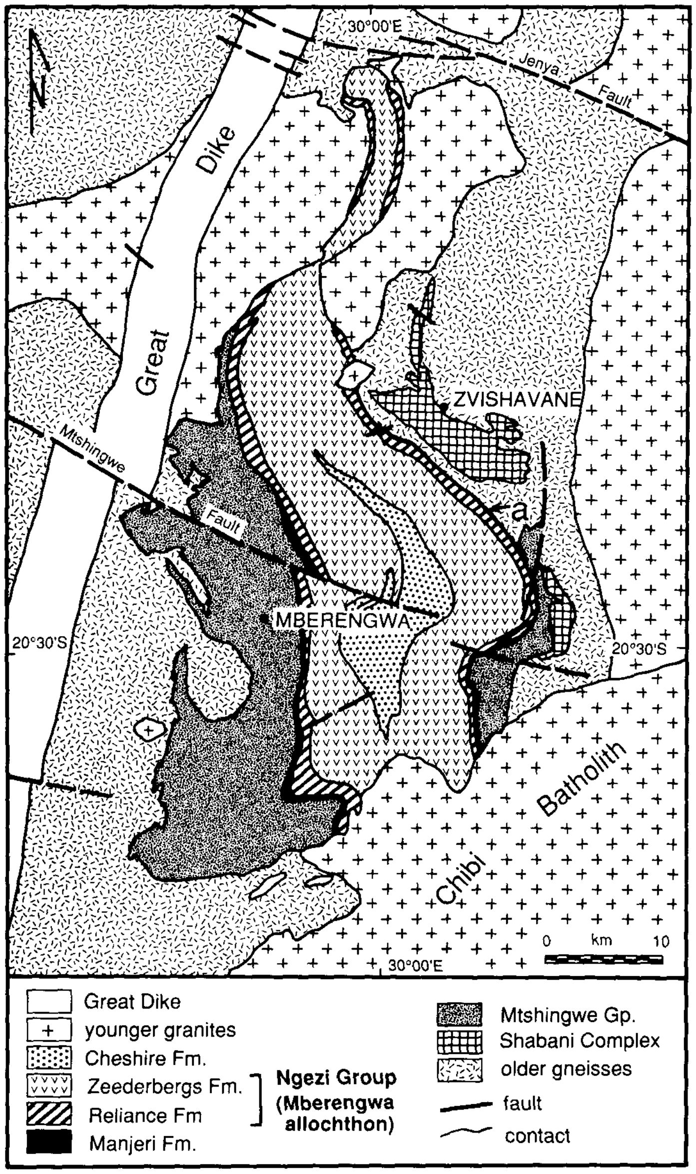

Figure 2. Geologic map of greenstone succession at Mberengwa (formerly Belingwe) and Zvishavane (formerly Shabani), Zimbabwe; a = unconformity location (see text). Map modified after Nisbet (1987), Orpen et al. (1985), and Martin (1979).

capped by what has been variably described as "a sulfide-bearing ironstone (now gossan)" (Bickle et al., 1975) and a "persistent horizon of predominantly sulfide facies banded iron formation" (Wilson, 1979), which we interpret as a regionally significant tectonic detachment surface (Kidd et al., 1988; Kusky, 1991b).

The proposed detachment at this level involves both the uppermost rocks of the Manjeri Formation and the lowermost rocks of the Reliance Formation. Bickle et al. (1975) described "small shears and tight asymmetric folds" at the top of the iron formation, but attributed little significance to these structures. Martin (1978) reported that the iron formation is locally brecciated. E. Nisbet (1989, personal commun.) reported that there are many major shear zones within the volcanic succession and elsewhere, the most obvious of which is along the Manjeri-Reliance contact. At the "classical unconformity location" (location a, Fig. 2), shallow-water sedimentary rocks of the Manjeri Formation grade upward into finely laminated iron formation, then into a several-metre-thick mylonite zone, and finally into rocks of the Reliance Formation that preserve good mafic and ultramafic primary textures. Because of the possible significance of the major shear zone at the top of the Manjeri Formation, we propose that the Manjeri Formation be excluded from the Ngezi Group, and that the term "Ngezi Group" be restricted to mafic and ultramafic rocks of the Reliance and Zeedersbergs Formations (Fig. 3).

Up to 6.5 km of ultramafic and mafic lavas, including komatiites, of the Reliance and Zeederbergs Formations structurally overlie the high-strain zone developed within and above the iron formation at the top of the Manjeri Formation (Fig. 3). The Reliance Formation, which is 0.5–1.0 km thick (Fig. 3), contains abundant basaltic and peridotitic komatiites, some with spinifex textures, whereas the 6-km-thick Zeederbergs Formation consists predominantly of tholeiitic basalts and basaltic andesites (Bickle et al., 1975; Nisbet et al., 1977). Pillow lavas are common in both the Reliance and Zeederbergs Formations, but the Zeederbergs Formation is also characterized by abundant hyaloclastites, pillow breccias, and tuffaceous rocks (Nisbet et al., 1977).

The Cheshire Formation is a heterogeneous succession of sedimentary rocks forming the stratigraphically highest level of the Ngezi Group (upper greenstones), located along the main synformal axis of the Belingwe greenstone belt (Fig. 2). It is ~2.5 km thick (Fig. 3) and consists of a variety of lithofacies, including conglomerate, sandstone, siltstone, limestone, cherty limestone, stromatolitic limestone, and minor banded iron formation of "very low" metamorphic grade (Martin, 1978). Petrographic work indicates that most conglomerates are derived from erosion and resedimentation of the underlying Zeederbergs Formation (Martin, 1978), suggesting an unconformable relation between the Cheshire Formation and underlying Zeederbergs Formation (cf. Martin, 1978). Martin (1978) described a general trend across the main synformal axis: i.e., thicker and more abundant conglomerates characterize the eastern flank of the synform, passing laterally across depositional strike into thinner and finer grained conglomerates along the western flank. The western flank is also characterized by abundant limestones, some stromatolitic, which extend laterally along strike for distances of several kilometres.

TECTONIC SIGNIFICANCE OF A DETACHMENT IN THE BELINGWE GREENSTONE BELT

The proposed detachment within the Belingwe greenstone belt requires separate consideration of rocks above and below the decollement. Previous workers have interpreted the Mtshingwe Group (lower greenstones) as a continental-rift deposit (Bickle et al., 1975; Nisbet, 1987). Descriptions of the wide variety of rock types, rapid lateral changes of facies, and well-exposed unconformable contacts with the lower gneiss in the Mtshingwe Group (Wilson, 1979; Martin, 1978), all of which are typical of younger rift deposits, are compatible with this interpretation, but fail to rule out a magmatic arc or other nonuniformitarian interpretation.

The base of the Manjeri Formation is marked by an unconformity, above which the section grades upward into a group of shallow-water sedimentary rocks remarkably like younger passive-margin sequences (Grotzinger, 1989). The top of this shallow-water section is marked by a drowning sequence (Grotzinger, 1989), which may reflect sediment-starved conditions on the thermally subsiding Manjeri platform or may have been induced by eustatic sea-level rise or by tectonic loading of the passive-margin sequence (Kidd et al., 1988; Grotzinger, 1989; Kusky, 1991b). The present sparse geochronological data do not allow these contrasting models for the drowning of the Manjeri shelf to be evaluated. The Ngezi Group overlies this drowning sequence but is in fault contact with the shallow-water sedimentary rocks, and no connection between the Manjeri Formation and the Ngezi Group has been demonstrated. We suggest that this is because the Ngezi Group is allochthonous with respect to the Manjeri Formation, and we propose the name "Mberengwa allochthon" for ultramafic and mafic rocks of the Reliance and Zeederbergs Formations, using the Zimbabwean name for "Belingwe."

E. G. Nisbet (1989, personal commun.) noted that there are many major shear zones in the Belingwe greenstone belt, including one in the ironstone band at the Manjeri-Reliance contact. However, Bickle et al. (1975) and Nisbet (1989, personal commun.) suggested that these shear zones are accommodation structures related to formation of the regional synform. This contention is inconsistent with the contrast between the ductile-mylonitic fabrics developed in hanging-wall rocks of the Reliance Formation, which must have formed when the ultramafic rocks of the Reliance Formation were still at elevated temperatures, and the very low grade of metamorphism preserved in the immediately underlying Manjeri Formation, which contains the assemblage sericite-chlorite (Martin, 1978). By analogy with younger contractional mountain belts, wherein zones of enormous displacement are commonly hidden in thin bedding-parallel detachment surfaces that place hot rocks of the hanging wall over lower grade rocks in the footwall, displacements along the Manjeri-Reliance contact are likely to be significant if our interpretation of the metamorphic contrast is correct. Considering the overall synclinal form of the Belingwe greenstone belt, simple trigonometry requires at least 28 km of slip along the basal detachment. Because no root zone for the Mberengwa allochthon has yet been identified and the transport direction for the allochthon is unknown, actual transport distances are likely to be much greater.

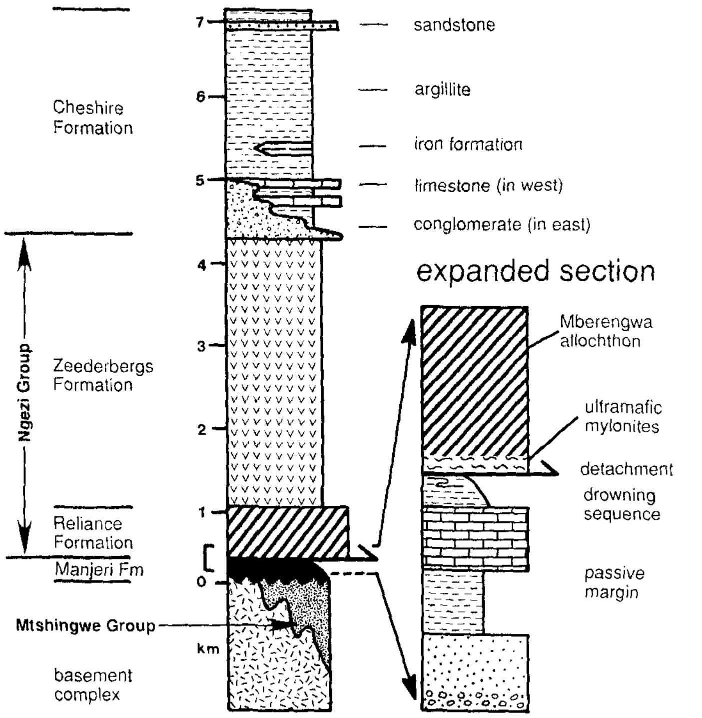

Figure 3. Interpretative stratigraphic column of Belingwe greenstone belt (modified after Grotzinger, 1989) showing location of proposed detachment between Manjeri and Reliance Formations.

Even discounting the proposed metamorphic jump across the shear zone at the Manjeri-Reliance contact, it is possible to discriminate between the two models for the origin of the shear zones in the Belingwe greenstone belt. We propose the following structural test of these hypotheses. If the detachment zone formed during late regional folding, kinematic indicators along the slip surfaces should indicate opposite senses of movement on either side of the Belingwe synform, whereas if the detachment zone formed during an earlier, high-temperature thrusting event, then kinematic indicators from either side of the synform should be similar when unfolded.

Unconformable relations akin to that at the base of the Cheshire Formation are similar to younger piggyback or parallochthonous basins deposited on moving thrust sheets, and also to "successor" or overlap basins (such as the Skeena fold belt [Bowser basin] in the Canadian Cordillera; Evenchick, 1991), which reflect a tectonic regime different from that of underlying rocks. In the piggyback basin model, the Cheshire Formation represents material shed from the tips of nearby thrust sheets and deposited locally in small parallochthonous foredeeps. In the successor basin model, the initiation and evolution of the Cheshire basin is related to tectonic events postdating the emplacement of the Reliance and Zeederbergs Formations. The west-to-east coarsening of facies and the restriction of carbonate lithologies to the western limb of the synform suggest that the Cheshire basin was asymmetric, the source area lying on the eastern side of the present synform.

IMPLICATIONS FOR PRECAMBRIAN TECTONICS

The lithotectonic assemblage in the Mberengwa allochthon contrasts strongly with that of younger rift- and flood-basalt sequences, but it is very similar to that found in younger ophiolites, oceanic plateaus, seamounts, and other sea-floor topographic highs (Burke, 1988; Hoffman, 1991). In Phanerozoic oceans, the great thickness of the lava section distinguishes oceanic plateau–type lithosphere from "normal" oceanic lithosphere (Burke, 1988). However, it is possible that in Precambrian oceans much of the oceanic lithosphere had a thicker crustal section and may have been generally more like younger oceanic plateaus (Sleep and Windley, 1982; Moores, 1986; Burke, 1988). Ultramafic rocks within these sections of Archean oceanic plateaus or thick oceanic crust are likely to be komatiitic flows reflecting slightly higher mantle temperatures, as opposed to mantle ultramafics, which would have been too deep to be flaked off at subduction zones (Burke, 1988; Hoffman and Ranalli, 1988). The ultramafic mylonites at the base of the Belingwe greenstone belt are comparable to dynamothermal aureoles found at the bases of younger obducted ophiolites.

Since the seminal contribution of MacGregor (1951), many workers have attempted regional correlations of greenstone belt assemblages across the Zimbabwe craton, assuming a "layer-cake" stratigraphy (e.g., Wilson, 1979, 1981). For much of this work, the Belingwe greenstone belt has served as the type locality for stratigraphic sections and relations (e.g., Wilson et al., 1990). The presence of a decollement surface carrying mafic and ultramafic lavas of the upper greenstones was not considered in regional correlations of this type. We suggest that the abundance of ca. 2.7 Ga greenstone belts in the Zimbabwe craton reflects a major crustal accretion event, such as the attempted subduction of an oceanic plateau during collision with a continental margin. A similar scenario has recently been proposed for the origin of the abundant 2.1 Ga mafic greenstone belts of the Birrimian terranes of northwest Africa (Abouchami et al., 1990). Collision, dismemberment, and preservation of fragments of large oceanic plateaus in short-lived crustal-accretion events have the potential to form structurally complex, spatially scattered greenstone belts with a uniform age over large areas of the planet, and together with a preservational bias, may be one important explanation of the apparent episodicity (e.g., Gastil, 1960; Hoffman, 1989b) of crustal formation ages reported from Precambrian terranes.

If our proposal about the allochthonous nature of the Belingwe greenstone belt is essentially correct, then we are aware of no good examples anywhere on Earth of ultramafic komatiite-bearing, mafic volcanic-dominated sections deposited on continental or continental-type lithosphere. We suggest that this is not an accident; as workers have suggested over the years, pillowed mafic volcanic-dominated submarine sections in the Archean, as in younger times, had origins either as oceanic crust or as subduction-generated volcanic arcs (including fore-arc, intra-arc and back-arc basin environments; Burke et al., 1976). Many Archean greenstone sections may prove to contain rocks from both sources. Whereas the example of the late Archean Ventersdorp Supergroup in the Kaapvaal craton shows that some basaltic komatiitic lavas were erupted in rift settings on continental lithosphere (Burke et al., 1985), that example also shows that it is not difficult to distinguish the assemblage of strata formed in such settings from those derived from oceanic and/or arc volcanism, emplaced tectonically and deformed in zones of subduction later modified by inevitable collision.

REFERENCES CITED

Abell, P.I., McClory, J., Martin, A., and Nisbet, E.G., 1985, Archean stromatolites from the Ngezi Group, Belingwe Greenstone Belt, Zimbabwe; preservation and stable isotopes—Preliminary results: Precambrian Research, v. 27, p. 357–383.

Abouchami, W., Boher, M., Michard, A., and Albarede, F., 1990, A major 2.1 Ga event of mafic magmatism in west Africa: An early stage of crustal accretion: Journal of Geophysical Research, v. 95, p. 17,605–17,629.

Bickle, M.J., and Eriksson, K., 1982, Evolution and subsidence of early Precambrian sedimentary basins: Royal Society of London Philosophical Transactions, ser. A, v. 305, p. 225–247.

Bickle, M.J., Martin, A., and Nisbet, E.G., 1975, Basaltic and peridotitic komatiites and stromatolites above a basal unconformity in the Belingwe Greenstone Belt, Rhodesia: Earth and Planetary Science Letters, v. 27, p. 155–162.

Burke, K., 1988, Tectonic evolution of the Caribbean: Annual Review of Earth and Planetary Sciences, v. 16, p. 201–230.

Burke, K., Dewey, J.F., and Kidd, W.S.F., 1976, Dominance of horizontal movements, arc and microcontinental collisions during the later permobile regime, *in* Windley, B.F., ed., The early history of the Earth: New York, John Wiley & Sons, p. 113–130.

Burke, K., Kidd, W.S.F., and Kusky, T.M., 1985, Is the Ventersdorp rift system of southern Africa related to a continental collision between the Kaapvaal cratons at 2.64 Ga ago?: Tectonophysics, v. 115, p. 1–24.

Condie, K.C., 1981, Archean greenstone belts: Amsterdam, Elsevier, 434 p.

de Wit, M.J., 1982, Sliding and overthrust nappe tectonics in the Barberton Greenstone Belt: Journal of Structural Geology, v. 4, p. 117–136.

de Wit, M., and Ashwal, L., eds., 1986, Workshop on the tectonic evolution of greenstone belts: Lunar and Planetary Institute Technical Report 86-10, 227 p.

de Wit, M.J., and Stern, C.R., 1981, Variations in the degree of crustal extension during formation of a back-arc basin: Tectonophysics, v. 72, p. 229–260.

de Wit, M.J., Armstrong, R., Hart, R., and Wilson, A., 1987, Felsic igneous rocks within the 3.3–3.5 Ga Barberton Greenstone Belt: High crustal level equivalents of the surrounding tonalite-trondhjemite terrain, emplaced during thrusting: Tectonics, v. 6, p. 529–549.

Evenchick, C.A.,1991, Geometry, evolution and tectonic framework of the Skeena Fold Belt, north-central British Columbia: Tectonics, v. 10, p. 527–546.

Gastil, G., 1960, The distribution of mineral dates in time and space: American Journal of Science, v. 258, p. 1–35.

Glover, J., and Ho, S., eds., 1990, Third international Archean symposium, extended abstracts volume: Perth, Western Australia, Geoconferences, 487 p.

Grotzinger, J.P., 1989, Facies and evolution of Precambrian carbonate depositional systems: Emergence of the modern platform archetype, *in* Crevello, P.D., Wilson, J.L., et al., Controls on carbonate platform and basin development: Society of Economic Paleontologists and Mineralogists Special Publication 44, p. 79–106.

Helmstaedt, H., Padgham, W.A., and Brophy, J., 1986, Multiple dikes in the Kam Group, Yellowknife Greenstone Belt: Evidence for Archean sea-floor spreading?: Geology, v. 14, p. 562–566.

Henderson, J.B., 1981, Archean basin evolution in the Slave Province, Canada, *in* Kröner, A., ed., Precambrian plate tectonics: Amsterdam, Elsevier, p. 213–235.

Hoffman, P.F., 1989a, Precambrian geology and tectonic history of North America: An overview, *in* Bally, A.W., and Palmer, A.R., eds., The geology of North America—An overview: Boulder, Colorado, Geological Society of America, The Geology of North America, v. A, p. 447–512.

—— 1989b, Speculations on Laurentia's first gigayear (2.0–1.0 Ga): Geology, v. 17, p. 135–138.

—— 1991, On accretion of granite-greenstone terranes, *in* Robert, F., et al., eds., Greenstone gold and crustal evolution: St. John's, Newfoundland, Geological Association of Canada, p. 32–45.

Hoffman, P.F., and Ranalli, G., 1988, Oceanic flake tectonics: Geophysical Research Letters, v. 15, p. 1077–1080.

Kidd, W.S.F., Kusky, T.M., and Bradley, D.C., 1988, Late Archean greenstone tectonics—Evidence for thermal and thrust loading lithospheric subsidence from stratigraphic sections in the Slave Province, Canada, *in* Ashwal, L.D., ed., Workshop on the deep crust of southern India: NASA–Lunar and Planetary Institute Technical Report 88-06, p. 79–80.

Kusky, T.M., 1989, Accretion of the Archean Slave Province: Geology, v. 17, p. 63–67.

—— 1990, Evidence for Archean ocean opening and closing in the southern Slave Province: Tectonics, v. 9, p. 1533–1563.

—— 1991a, Structural development of an Archean orogen, western Point Lake, Canada: Tectonics, v. 10, p. 820–841.

—— 1991b, Are the upper greenstones at Belingwe (Zimbabwe) allochthonous?, *in* Lunar and Planetary Science Conference, 22nd: Houston, Texas, Lunar and Planetary Institute, p. 769–770.

MacGregor, A.M., 1951, Some milestones in the Precambrian of southern Rhodesia: Geological Survey of Southern Rhodesia Proceedings, v. 38, p. 27–71.

Martin, A., 1978, The geology of the Belingwe-Shabani schist belt: Rhodesia Geological Survey Bulletin 83, 213 p.

—— 1979, Belingwe—Shabani (map to accompany Bulletin no. 83): Geological Survey of Zimbabwe, scale 1:100,000.

Martin, A., Nisbet, E.G., and Bickle, M.J., 1980, Archean stromatolites of the Belingwe Greenstone Belt, Zimbabwe (Rhodesia): Precambrian Research, v. 13, p. 337–362.

McKenzie, D.P., Nisbet, E.G., and Sclater, J.G., 1980, Sedimentary basin development in the Archean: Earth and Planetary Science Letters, v. 48, p. 35–41.

Moores, E.M., 1986, The Proterozoic ophiolite problem, continental emergence, and the Venus connection: Science, v. 234, p. 65–68.

Nisbet, E.G., 1987, The young Earth: An introduction to Archean geology: Boston, Allen and Unwin, 402 p.

Nisbet, E.G., Bickle, M.J., and Martin, A., 1977, The mafic and ultramafic lavas of the Belingwe Greenstone Belt, Rhodesia: Journal of Petrology, v. 18, p. 521–566.

Orpen, J.L., Bickle, M.J., Nisbet, E.G., and Martin, A., 1985, Belingwe Peak: Harare, Zimbabwe Geological Series, scale 1:100,000.

Sleep, N.H., and Windley, B.F., 1982, Archean plate tectonics: Constraints and inferences: Journal of Geology, v. 90, p. 363–379.

Tankard, A.J., Jackson, M.P.A., Eriksson, K.A., Hobday, D.K., Hunter, D.R., and Minter, W.E.L., 1982, Crustal evolution of southern Africa: New York, Springer-Verlag, 523 p.

Tarney, J., Dalziel, I.W.D., and de Wit, M.J., 1976, Marginal basin "Rocas Verdes" complex from southern Chile: A model for Archean greenstone belt formation, *in* Windley, B.F., ed., The early history of the Earth: New York, John Wiley & Sons, p. 131–146.

Wilks, M.E., and Nisbet, E.G., 1988, Stratigraphy of the Steep Rock Group, northwest Ontario: A major Archean unconformity and Archean stromatolites: Canadian Journal of Earth Sciences, v. 25, p. 370–391.

Wilson, J.F., 1979, A preliminary reappraisal of the Rhodesian basement complex: Geological Society of South Africa Special Publication 5, p. 1–23.

—— 1981, The granite-greenstone shield, Zimbabwe, *in* Hunter, D.R., ed., Precambrian of the Southern Hemisphere: Amsterdam, Elsevier, p. 454–488.

Wilson, J.F., Bickle, M.J., Hawkesworth, C.J., Martin, A., Nisbet, E.G., and Orpen, J.L., 1978, Granite-greenstone terranes of the Rhodesian Archean craton: Nature, v. 271, p. 23–27.

Wilson, J.F., Baglow, N., Orpen, J.L., and Tsomondo, J.M., 1990, A reassessment of some regional correlations of greenstone belt rocks in Zimbabwe and their significance in the development of the Archean Craton, *in* Glover, J., and Ho, S., eds., Third international Archean symposium, extended abstracts volume: Perth, Western Australia, Geoconferences, p. 43–44.

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