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Abstract: The Paleoproterozoic Baoulé-Mossi domain of the southern West African Craton is regarded as the result of juvenile crust formation during the 2.3-1.9 Ga period. However, little is known about the complex processes that led to the formation of this highly metal endowed lithospheric block. Hence, in order to better constrain its geodynamic evolution, small catchments within modern drainage basins of the Niger and Bani Rivers were sampled for detrital zircons for U-Pb and Hf-isotope analyses, following TerraneChron® methodology. The study area stretched across southern Mali over 15 000 km² between the Yanfolila (west) and Syama (east) belts, from where more than 1000 zircons representing eight different sub-basins have been analyzed.

The results of this study identified 2 main zircon age populations. The older population with ages between 3.6 and 2.7 Ga represents approximately 10% of the total of the analyzed zircons, and is mainly restricted to the western margin of the study area across the Yanfolila Belt sampling sites. The Hf-isotope data from this zircon population yielded model ages between 3.7 to 3.6 Ga and suggest a common evolution. Conversely, the main zircon population is dominated by Paleoproterozoic age zircons ranging between 2.4 and 2.1 Ga. Main peaks within this age group were identified at ca. 2161, 2121 and 2084 Ma, and minor peaks at ca. 2343, 2263 and 2200 Ma. The Hf-isotope data of this age group indicate that the zircons are derived from a mainly juvenile source, but were contaminated with crustal rocks as old as 2.8 Ga; however, small amount of Paleoproterozoic age zircons have a minor older component, potentially up to 3.7 Ga. This group of zircons of Paleoproterozoic age but Hf signatures up to 3.7 Ga is considered to be transported grains.

This study also highlights the occurrence of > 2.7 Ga detrital zircons, which are of an unknown source as no rock unit in the region has been identified to yield similar Archean ages. Moreover, some Paleoproterozoic zircons show Hf-isotope composition that indicates reworking of an older crustal component. Although zircons of the Baoulé-Mossi domain generally confirm its juvenile origin, they also indicate reworking of the older crust at a larger scale than previously recognized. The

identification of Archean zircons in the region argues for greater interaction between the Baoulé-Mossi domain and the Archean Kénéma-Man domain.

Perth, March 5, 2015

Dear Editor

Precambrian Research

It is with great pleasure that I submit the manuscript entitled “Crustal Evolution of the Paleoproterozoic Birimian terranes of the Baoulé-Mossi domain, southern West African Craton: U-Pb and Hf-isotope studies of detrital zircons” by Luis A. Parra-Avila, Elena Belousova, Marco L. Fiorentini, Lenka Baratoux, James Davis, John Miller and T. Campbell McCuaig.

This work is based on U-Pb ages and Lu-Hf isotope in situ measurements on zircons obtained from detrital samples collected from small river catchments across southern Mali. The study seeks to provide information over the crustal evolution of the Paleoproterozoic Baoulé-Mossi domain of the West African Craton. The lack of easy accessible outcrops and the extension of the study area make this method ideal to provide a more complete overview of the crustal evolution of the study area. By using this method it was possible to identify zircon populations with Archean U-Pb ages and Lu-Hf signatures that have not been recognized before. The new data show a greater interaction between Archean and Paleoproterozoic domains not previously identified.

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We thank you in advance for your attention and hope to receive comments and reviews in the near future.

Sincerely,

Luis A. Parra-Avila

Crustal Evolution of the Paleoproterozoic Birimian terranes of the Baoulé-Mossi domain, southern West African Craton: U-Pb and Hf-isotope studies of detrital zircons

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Abstract

The Paleoproterozoic Baoulé-Mossi domain of the southern West African Craton is regarded as the result of juvenile crust formation during the 2.3-1.9 Ga period. However, little is known about the complex processes that led to the formation of this highly metal endowed lithospheric block. Hence, in order to better constrain its geodynamic evolution, small catchments within modern drainage basins of the Niger and Bani Rivers were sampled for detrital zircons for U-Pb and Hf-isotope analyses, following TerraneChron[®] methodology. The study area stretched across southern Mali over 15 000 km² between the Yanfolila (west) and Syama (east) belts, from where more than 1000 zircons representing eight different sub-basins have been analyzed.

The results of this study identified 2 main zircon age populations. The older population with ages between 3.6 and 2.7 Ga represents approximately 10% of the total of the analyzed zircons, and is mainly restricted to the western margin of the study area across the Yanfolila Belt sampling sites. The Hf-isotope data from this zircon population yielded model ages between 3.7 to 3.6 Ga and suggest a common evolution. Conversely, the main zircon population is dominated by Paleoproterozoic age zircons ranging between 2.4 and 2.1 Ga. Main peaks within this age group were identified at ca. 2161, 2121 and 2084 Ma, and minor peaks at ca. 2343, 2263 and 2200 Ma. The Hf-isotope data of this age group indicate that the zircons are derived from a mainly juvenile source, but were contaminated with crustal rocks as old as 2.8 Ga; however, small amount of Paleoproterozoic age zircons have a minor older component, potentially up to 3.7 Ga. This group of zircons of Paleoproterozoic age but Hf signatures up to 3.7 Ga is considered to be transported grains.

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ages. Moreover, some Paleoproterozoic zircons show Hf-isotope composition that indicates reworking of an older crustal component. Although zircons of the Baoulé-Mossi domain generally confirm its juvenile origin, they also indicate reworking of the older crust at a larger scale than previously recognized. The identification of Archean zircons in the region argues for greater interaction between the Baoulé-Mossi domain and the Archean Kénéma-Man domain.

Keywords

TerraneChron[®], U-Pb zircon dating, Lu-Hf isotopes, Southern West Africa Craton, Baoulé-Mossi domain, Mali

1 Introduction

The southern West African Craton (SWAC) and in particular the Birimian terranes of the Baoulé-Mossi domain extend over large portions of Burkina Faso, Côte d'Ivoire, Ghana, Guinea, Liberia, Mali, Niger, Senegal and Togo. The current level of knowledge on the evolution history of this block of crust is limited and subject of multiple debates and controversies, which are mainly due to the absence of reliable geochemical and geochronological data as well as to the lack of integration of all these datasets with existing geophysical data.

Although some of the controversies regarding the southern West African Craton have been settled (e.g. stratigraphy of the Leo-Man rise as discussed in Vidal et al. (1996), and recognized by Béziat et al. (2000); Roddaz et al. (2007); Béziat et al. (2008); Lompo (2009); Hein (2010); Baratoux et al. (2011); Metelka et al. (2011); and Ganne et al. (2014)), there is still much debate over the general geodynamic regime that assembled the West African Craton. Confronting theories include vertical tectonics (Doumbia et al., 1998; Vidal et al.,

2009; Lompo, 2010) vs. modern plate tectonic regime, as supported by Feybesse and Milési (1994); Ledru et al. (1994); Allibone et al. (2002); and Feybesse et al. (2006a). Moreover, it is not clear if the Birimian terranes were formed as the result of a volcanic island arc system (Sylvester and Attoh, 1992; Béziat et al., 2000; Baratoux et al., 2011; Tapsoba et al., 2013; Ganne et al., 2014) or another tectonic environment. In addition, authors such as Begg et al. (2009) suggest that as for the rest of Africa, the West African Craton resulted from the accretion of smaller Archean blocks, whereas Abouchami et al. (1990); Boher et al. (1992); and Taylor et al. (1992) support the idea that the craton resulted from the accretion of mostly juvenile crust.

The southern West African Craton host multiple world-class gold and base metal mineral systems that occur throughout Ghana, Burkina Faso, Mali and Guinea (Milési et al., 1992; Feybesse et al., 2006a; Béziat et al., 2008). However, while most of the structural, geochronological, and geochemical studies carried out over the southern West African Craton have been at the scale of individual countries, none of the previous studies on the region have attempted to resolve in-depth regional-scale correlations. The application of the TerraneChron[®] methodology (Griffin et al., 2004; Veevers et al., 2005; Belousova et al., 2006; Griffin et al., 2006; Griffin et al., 2007; O'Reilly et al., 2008; Belousova et al., 2009) addresses the lack of a broad integrated picture across the craton, provides a tool to study the crustal evolution and evaluates the metallogenic potential of the southern West African Craton, with a particular focus on the Paleoproterozoic Birimian terranes of the Baoulé-Mossi domain.

This methodology incorporates the *in situ* determination of U-Pb age, Hf-isotope and trace-element composition in zircons. The technique can be applied to zircons either separated from individual rock samples or zircons collected from carefully selected catchments within modern small drainage basins. The use of detrital zircons obtained from

drainage basins takes advantage of the erosion-resistant properties of zircon and provides a comprehensive coverage of rock types within the drainage area.

This study covered eight sub-basins across southern Mali within the Baoulé-Mossi Paleoproterozoic domain. One sub-basin belongs to the Niger River while the remaining seven belong to the Bani River. The results of the study show that the main population of detrital zircons is Paleoproterozoic in age, ranging between 2.4 and 2.0 Ga with Hf-isotope model ages between 2.8 and 2.2 Ga. A small population of Archean zircons (between ca. 3.6 and 2.7 Ga) have Hf-isotope composition that suggest a crustal source with age of 3.7-3.6 Ga.

The aim of this study is to provide constraints over the crustal evolution of the Paleoproterozoic Baoulé-Mossi domain and its possible interaction with the Archean Kénéma-Man domain. The data presented in this study is significant because it shows the presence of zircons with ages older than 2.4 Ga not previously identified in the region, which highlights the possible interaction with an Archean substrate.

2 Geological Setting

2.1 The West African Craton

The West African Craton (WAC) has been stable since ca. 1.9 Ga and consists of three major blocks: the Reguibat rise, the Kedougou-Kenieba and Kayes Inliers and the Leo-Man rise, all of which surround the Taoudenni Basin (Bessoles, 1977; Black et al., 1980; Abouchami et al., 1990). The combined extension of the previously mentioned blocks together with the Taoudenni Basin is around 3000000 km² (Figure 1) (Black et al., 1980; Abouchami et al., 1990; Rocci et al., 1991; Sylvester and Attah, 1992). In terms of surface area the Taoudenni Basin province represents the dominant sedimentary sequence of the West African Craton. It is a Late Proterozoic to Phanerozoic platform of cratonic sediments

bounded by the Reguibat rise to the north, the Leo-Man rise to the south and by the Paleoproterozoic Kedougou-Kenieba and Kayes Inliers that run between the Reguibat and the Leo-Man to the west (Bessoles, 1977; Black et al., 1980; Sylvester and Attah, 1992; Lompo, 2010). The Reguibat rise and the Leo-Man rise provinces are composed mainly of Archean nuclei in their western portions and Paleoproterozoic rock exposures in their eastern segments (Black et al., 1980; Abouchami et al., 1990; Rocci et al., 1991; Sylvester and Attah, 1992; Lompo, 2010).

2.2 The Leo-Man rise

The southern portion of the West African Craton is referred to as the Leo-Man rise (Baratoux et al., 2011; Metelka et al., 2011; Perrouty et al., 2012), and is divided into the Archean Kénéma-Man domain to the west and the Paleoproterozoic Birimian rocks of the Baoulé-Mossi domain to the east (Figure 1). The Archean domain represents most of the geology of Sierra Leone, Liberia, Guinea, and it is bounded by the Sassandra fault to the east, across Côte d'Ivoire (Rocci et al., 1991; Boher et al., 1992). Although the debate remains over the extent and the characteristics of the Archean rock basement as well as its relationship with the Paleoproterozoic domain, it is widely accepted that the Archean basement is most likely the result of the Leonian (ca. 3.0-2.9 Ga) and Liberian (ca. 2.8-2.7- Ga) orogenic cycles (Black et al., 1980; Boher et al., 1992; Feybesse and Milési, 1994; Kouamelan et al., 1997; Thiéblemont et al., 2001; Egal et al., 2002; Thiéblemont et al., 2004), with the oldest known age reported by Thiéblemont et al. (2001) at 3535 ± 9 Ma. The Archean portion was overprinted by medium to high grade (amphibolite-granulite facies) metamorphism, with dominant rock type consisting of tonalite-trondhjemite-gneiss (TTG), overlain by greenstone belts which were later intruded by granitic bodies (Beckinsale et al., 1980; Black et al., 1980; Feybesse and Milési, 1994).

The Baoulé-Mossi domain is dominated by the Birimian Group, which was first described by Junner (1954); however, *sensu stricto* the definition was only applied for the greenstone volcanic belts. The Birimian which cover large portions of Côte d'Ivoire, Mali, Burkina Faso, Niger and to a lesser extend Guinea, Senegal and Togo, is generally defined by Paleoproterozoic rocks ca. 2.2-2.0 Ga, by Abouchami et al. (1990) and Boher et al. (1992). The Birimian terranes *sensu lato* are comprised of: (1) relatively narrow volcano-sedimentary basins and linear or/and arcuate volcanic belts (greenstone belts-basin); (2) granitoid-TTG terranes; and (3) contemporaneous or slightly younger sedimentary basins (e.g. Kuasi, Siguiri, Sunyani). In addition, there are late-basins (e.g. Tarkwa, Bui), which are still under debate as whether they are Birimian or not. These Paleoproterozoic belt-basins consist mainly of tholeiitic and in some cases calc-alkaline basaltic lava flows, filled with sedimentary sequences composed of shales and sandstones, as well as volcanogenic and flysh-type turbidite rocks (Bessoles, 1977; Leube et al., 1990; Milési et al., 1992; Sylvester and Attoh, 1992; Béziat et al., 2000; Roddaz et al., 2007; Lompo, 2009).

From the bottom to the top, the Birimian Paleoproterozoic formation *sensu lato* includes a basal thick sequence of mafic lithologies, such as basalts, dolerites and gabbros, which are of tholeiitic composition. The next unit is comprised of detrital sediments that include volcanic rocks, turbidite sequences, as well as mudstones and carbonates. These detrital sediments are occasionally interlayered with calc-alkaline volcanics. The entire stratigraphic sequence was affected by the Eburnean orogeny, which resulted in greenschist facies regional metamorphism (Agyei et al., 1987; Abouchami et al., 1990; Hirdes et al., 1992; Taylor et al., 1992; Oberthuer et al., 1996), and locally amphibolite and even granulite facies metamorphism (Block et al., in press). The Eburnean orogeny occurred at ca. 2.1 Ga and is characterized by a domain wide occurrence of granitic intrusions that locally present similar metamorphic characteristics as the rest of the Birimian stratigraphic sequence.

The Birimian terranes are intruded by pre-, syn- and post- kinematic granitic rocks that represent up to 50% of the surface exposures in the domain (Boher et al., 1992; Roddaz et al., 2007; Lompo, 2009). These granitic intrusions, which separate and locally intrude the greenstone belts, are mostly classified as tonalites-granodiorites and monzogranites. They are considered to be similar to typical Late Archean granitic intrusions from the Superior, Dharwar and Yilgarn cratons (Martin, 1994; Champion et al., 2001; Moyen et al., 2003; Martin et al., 2005; Baratoux et al., 2011).

The Paleoproterozoic terranes of the West African Craton and in particular the ones of the Baoulé-Mossi domain are considered by some authors (e.g. Abouchami et al., 1990; Boher et al., 1992; Taylor et al., 1992) to represent mostly juvenile crust with limited reworking of old Archean crustal material that resulted from a very short tectonic event that has been reported to last ca. 100 Ma (Abouchami et al., 1990; Boher et al., 1992; Hirdes et al., 1992). Their conclusions are based mostly on Pb-Pb isochron age results, as well as Sm/Nd isotope studies and a limited number of zircon U-Pb dates. In contrast, on the basis of geophysical and geochemical data, Begg et al. (2009) suggested that modern Africa is the result of the accretion of multiple Archean cratons along with smaller cratonic fragments, stitched together. These authors also indicate that the larger cratons are underlain by ancient rigid, robust and highly geochemically depleted Subcontinental Lithospheric Mantle (SCLM).

In the West African Craton, most of the early crustal fragments are covered either by the Taoudenni Basin or by Paleoproterozoic Supracrustals terranes. In the southern portion of the craton, the Paleoproterozoic Birimian Group comprises associated greenstone belts and corresponding intruding granitic bodies related to the Eburnean orogeny between ca. 2.2 and 1.8 Ga. The results from the TerraneChron[®] study (Griffin et al., 2004; Veevers et al., 2005;

Belousova et al., 2006; Griffin et al., 2006; Griffin et al., 2007; O'Reilly et al., 2008; Belousova et al., 2009) presented here provide key insights into the debate on juvenile crust vs. Archean fragment accretion, providing much needed information over the proportion of juvenile and older crustal component within the Birimian rocks.

2.2.1 Southern Mali

The study area in southern Mali is dominated by three volcano-sedimentary belts that strike NE-SW, which are from west to east: the Yanfolila Belt, approximately 600 km wide, found alongside the eastern margin of the Siguiri Basin, and cut by the Siekerole Shear Zone (SSZ); the Morila Belt, which is located within a large TTG domain along the Bougouni region that dominates most of southern central Mali; and the Syama Belt located along the Mali-Burkina Faso border. The latter two belts are separated by the regional Benafin Shear Zone (BSZ) (Figure 2).

The Yanfolila Belt located along the Guinea and Mali border is cut by the SSZ, which splits the belt into a western and eastern side. This belt comprises arc related volcanic suites typical of the Birimian package, locally known as the Nani Volcanic formation, and reworked greywacke sequences similar to those found in the Siguiri Basin. The Nani Volcanic formation comprises coarse to very large or megacrystic tholeiitic basalt and basaltic andesite rocks, intercalated with a sequence of strongly deformed porphyritic rhyolitic–dacitic lavas, pyroclastic flows and pyroclastic breccias.

The Morila Belt is situated within a large domain that is dominated by the Massigui and Doubakoro granites, which belong to a composite TTG style granitic intrusive complex of the Bougouni region. Within the complex, the Birimian units consist of basalt to basaltic-andesite lavas, locally pillowed and inter-bedded with a variety of volcano-sedimentary

rocks. The rock units from the belt and associated large TTG complex domain are characterized by amphibolite grade metamorphism, partially due to contact metamorphism.

The Syama Belt is located on the border between Mali and Burkina Faso and is characterized by a sequence of basalts and andesitic rocks inter-bedded with greywacke and argillites (Olson et al., 1992). The overall belt stratigraphy is similar to the one of the Yanfolila Belt, but it is also structurally imbricated and intensely folded and commonly overturned. Regional plutonic activities have been dated at ca. 2074 ± 9 , 2098 ± 5 , 2136 ± 6 and 2152 ± 16 Ma (Liégeois et al., 1991; Olson et al., 1992).

3 Geochronology Synthesis

McFarlane et al. (2011) suggested that the volcano-sedimentary belts-basins that form the southern West African Craton provide a complete record of the crustal growth of the region. However, the existing geochronological datasets across the Birimian terranes of the Baoulé-Mossi domain are fragmented and very few studies have attempted regional scale correlations. Overall, the Baoulé-Mossi domain is dominated by volcanic and volcano-sedimentary belts that formed between ca. 2250-2000 Ma along with what have been described as syn- to post- tectonic granitic intrusions (Feybesse et al., 2006a; Baratoux et al., 2011; Tapsoba et al., 2013), which were accreted to the Archean block at around 2.1 Ga (Abouchami et al., 1990; Boher et al., 1992; Taylor et al., 1992). Despite the limitations in the geochronological studies, multiple authors have described that the felsic plutonic emplacement appears to be continuous for the period mentioned above. In addition, these authors described clusters of activity at around 2210-2190, 2180-2150, 2110-2100 and 2090-2070 Ma (Liégeois et al., 1991; Hirdes et al., 1992; Hirdes et al., 1996; Kouamelan et al., 1997; Doumbia et al., 1998; Oberthür et al., 1998; Egal et al., 2002; Gasquet et al., 2003; de Kock et al., 2012).

The geochronological history of the southern West African Craton intrusions is still subject of debate, especially in southern Mali. In general, most of the previous geochronological work has been restricted to the areas related to mine sites or known mineral deposits. The Yanfolila Belt, as previously described, is characterized by transition units between arc related volcanic suites that characterize the Birimian package and units representative of the Siguiri Basin formation. The Siguiri Basin yield a maximum depositional age of 2093 ± 2 Ma (Lahondère et al., 2002), whereas volcanics of the Niani formation have been dated at 2212 ± 6 Ma (Lahondère et al., 2002). In addition, zircons from sedimentary units in the Yanfolila Belt yield depositional ages between ca. 2150 - 2095Ma, and zircons as old as ca. 2300 Ma have been identified within the Birimian volcanoclastics and greywacke units of the eastern portion of the belt (James Davis, personal communication). Furthermore, granitic intrusions along the Yanfolila Belt range from ca. 2150 Ma and 2075 Ma (Parra-Avila, 2015). Felsic intrusions yielding similar ages as the ones reported before are also found along the SSZ, the Morila Belt (ca. 2132-2097 Ma, McFarlane et al., 2011) and the BSZ, and are dominated by the Siekerole, Missigui and Doubakoro granitic suits (Parra-Avila, 2015). In the case of the Syama Belt, the geochronological history is described by Liégeois et al. (1991) and Olson et al. (1992).

4 Sampling Methods and Sample Processing

In order to gain a better understanding of the evolution of the southern West African Craton, samples were collected from carefully selected small drainage catchments, from which zircons were separated to be analyzed *in situ* to determine their U-Pb age and Hf isotopic composition (model age and source characteristics) by means of LAM-ICPMS and LAM-MC-ICPMS, respectively. This approach is known as TerraneChron® (Griffin et al., 2004; Veevers et al., 2005; Belousova et al., 2006; Griffin et al., 2006; Griffin et al., 2007;

O'Reilly et al., 2008; Belousova et al., 2009), and was developed by the ARC National Key Centre for Geochemical Evolution and Metallogenic of Continents (GEMOC) at the Department of Earth and Planetary Sciences, Macquarie University, Sydney, Australia. The approach capitalizes on the erosion-resistant properties of zircon and offers some sampling advantages, where nature has separated and concentrated a statistically more meaningful sample than is achievable by conventional single rock sampling and methods, and thus can provide a more comprehensive coverage of rock types within the drainage area. In order to obtain representative and statistically meaningful data, it requires around 60-80 randomly selected grains as well as grains deemed to represent all populations (Andersen, 2005).

In situ U-Pb analyses on zircons allow the determination of crystallization ages of the host rock, while the Lu-Hf isotopic system provides information pertinent to the source of the rock from which the zircon crystallized, distinguishing if the magmatism involved young mantle-derived input or if pre-existing crust was involved (e.g. crustal reworking). Combination of U-Pb and Hf-isotope data thus provides a broad picture of crustal evolution in the sampled area (Griffin et al., 2000; Griffin et al., 2004; Griffin et al., 2005; Griffin et al., 2007; O'Reilly et al., 2008). Overall, zircon is considered to be an extraordinary mineral due to its abundant occurrence, which includes crustal and lunar rocks, mantle xenoliths, and meteorites and a wide range of terrestrial environments. In addition, zircon grains are chemically stable and refractory, which allows them to resist weathering and transport processes as well as high temperature metamorphism (Speer, 1980; Belousova et al., 2002). The advantage of using zircons over other minerals to determine U-Pb age and Hf-isotope compositions is that zircon grains are usually formed early, and in many cases they are bounded by later forming minerals. Additionally, during their crystallization process the zircon grains tend to include trace elements and radionuclides such as zirconium, hafnium, as well as yttrium, thorium, uranium, neodymium, and tantalum, therefore retaining information

over the original composition of the melt that crystallized to form the rock (Speer, 1980; Andersen, 2002; Belousova et al., 2002; Jackson et al., 2004).

During the 2012 (February-March) field season in the Baoulé-Mossi domain, twenty two samples were collected across southern Mali, stretching from the Guinea-Mali to the Mali-Burkina Faso border (Figure 3). Samples represent the two main drainage basins of southern Mali, covering around 40000 km²: (1) Niger River basin, on the western portion; and (2) the Bani River basin, in the eastern portion of the study area. At the scale of this study, the two basins represent distinctive drainages and thus different provenance sources. However, at a more regional scale, the Bani River drainage system is drawn into the Niger River Basin, eventually forming a single drainage system dominated by the later river. The basins and sub-basins have been defined on the basis of the United States Geological Survey (USGS) drainage system map for the region (Lehner, 2006), which was used in conjunction with topographic maps during the selection of the sample sites.

The sample localities vary from dry gullies and small creeks to relatively large rivers (up to 100 m wide). In general, the sampled material represents a mixture of clays, mud, sand and gravel, with a total weight of individual sample ranging from 10 kg to 20 kg. Within the Niger River basin, 4 samples collected from 4 drainage areas represent 1 sub-basin, which will be referred to as the Yanfolila-Kalana sub-basin. The sampling in the Bani River drainage system included 18 samples, representing 18 different drainage areas that can be grouped into 8 sub-basins. These sub-basins from west to east are: Yanfolila west (samples ML5, ML6, ML11, ML12 and ML13); Yanfolila north (samples ML16 and ML17); samples ML10 and ML14 are part of the sub-basin that will be referred to as Yanfolila east; sample ML8 represents the Yanfolila south sub-basin. Within the large TTG intrusive complex and the Morila Belt, samples ML7 and ML9 will be referred to as Morila south; Morila north

includes sample ML15; sample ML18 will be referred to as part of the Morila northeast sub-basin; and finally sample ML21 represents the Syama sub-basin (Table 1, Figure 3).

Sample processing included panning on site to reduce the sample to a heavy mineral concentrate and thus reducing sample weight down to 0.1 - 0.5 kg. From these concentrates, zircons were separated in the laboratory using traditional techniques (e.g. heavy liquid and electromagnetic separation) as described by Belousova et al. (2006); Griffin et al. (2006). Resulting heavy mineral concentrates were sorted and zircons were handpicked using a Leica binocular microscope. Because the TerraneChron[®] approach samples entire drainage system catchments, it is possible that the zircons collected during the sampling process are derived from multiple source rocks and represent several age populations. Therefore, careful analysis of the selected grains and of the analytical data is extremely important to obtain statistically meaningful results. 80 to 100 zircons representing all the populations identified within each sample as well as some randomly selected grains were carefully mounted in 2.5 cm diameter epoxy discs (2-3 samples per disc). The discs were polished and later imaged with backscatter electron (BSE) and cathodoluminescence (CL) detectors of a Tescan Vega 3 analytical SEM system at the Centre for Microscopy, Characterization and Analysis (CMCA) located in the University of Western Australia, Perth, Australia. The collected CL images show internal structures and allow the identification of inclusions, fractures, metamict domains and observation of general crystal morphology.

Understanding the internal structure and zoning of the grains makes it possible to identify the occurrences of cores and rims. In addition, the BSE and CL images provide a tool that allows a preliminary identification of zircons of igneous vs. metamorphic origin, based on their crystal morphology. This initial identification based on BSE/CL images can be later confirmed during U-Pb dating and trace-element analysis (e.g. Th/U ratio) of grains or

domains that have a metamorphic appearance. Zircons of igneous/magmatic origin usually present a very distinctive oscillatory zoning, which is typically absent in the grains of metamorphic origin. Some general characteristics of magmatic zircons are internal zoning as well as euhedral and/or elongated shapes. On the contrary, metamorphic grains usually lack or have very weak internal zoning, while the shapes of the grain tend to be more rounded and/or anhedral. In conjunction with the internal zoning and external crystal morphology, another indicator that helps to identify metamorphic zircons is their low Th/U ratio, which is usually below 0.05 (Rubatto et al., 1999; Rubatto, 2002). It is important to keep in mind that these characteristics are not absolute and that the analyzed grains should be carefully evaluated on individual basis (Rubatto et al., 1999; Rubatto, 2002; Griffin et al., 2004).

A total of 2853 zircons were mounted for all the samples available for this study, from which 599 are representative of the Niger River Basin and 2254 grains represent the Bani River Basin. All 2853 zircons were carefully imaged using BSE and CL techniques in order to gain a rapid broad classification of the grains as magmatic or metamorphic as well as to avoid grains or areas of grains that are extensively fractured or metamict.

5 Analytical Methods

5.1 U-Pb Dating

The U-Pb dating was carried out at the GEMOC/CCFS Centre using an Agilent 7700 quadrupole Inducted Coupled Plasma Mass Spectrometer (ICP-MS), that was attached to a New Wave/Merchantek UP-213 laser ablation system ($\lambda=213$ nm). The beam diameter was set at 30 or 40 μm , depending on zircon size, with a 5 Hz repetition rate and energy of around 0.06 μJ and 8 J/cm^2 . The ablation process was performed in He to increase sample transport efficiency and to provide a more stable signal, which in turn produces a more reproducible

Pb/U fractionation. Detailed procedures have been described in Belousova et al. (2001) and Jackson et al. (2004).

Runs of 12 unknown samples were analyzed perform in between pairs of analyses of the GEMOC GJ-1 zircon standard (Elhlou et al., 2006) at the beginning and end of each run. The GJ-1 standard is slightly discordant, with a TIMS, $^{207}\text{Pb}/^{206}\text{Pb}$ age of 608.5 Ma (Jackson et al., 2004). Secondary zircon standards 91500 and Mud Tank were analyzed within the run as an independent control on reproducibility and instrument stability. The software package GLITTER was used to calculate U–Pb ages from the raw signal data (Griffin et al., 2008). This software is based on calculations of the relevant isotopic ratios for each mass sweep, displaying them as time-resolved data. By doing this the operator can select the most stable homogeneous segments of the signal for integration. The software corrects the integrated ratios for ablation related fractionation and instrumental mass bias by calibrating each selected time segment against the matching time segments for the standard zircon analyses (Jackson et al., 2004; Griffin et al., 2008). In addition, the common-Pb correction procedure of Andersen (2002); Andersen et al. (2004) was used and the analyses of the present study were corrected assuming recent Pb-loss with a common-Pb composition equivalent to present day average orogenic Pb as given by the second-stage growth curve of Stacey and Kramers (1975) for $^{238}\text{U}/^{204}\text{Pb} = 9.74$. No correction has been applied to analyses that are concordant within 2σ analytical error in $^{206}\text{Pb}/^{238}\text{U}$ and $^{207}\text{Pb}/^{235}\text{U}$, or which have less than 0.2% common-Pb.

Further data processing included evaluation of U-Pb age discordance and recognition of grains with the high common-Pb component. For the purpose of this study accepted U-Pb ages were limited to a discordance that ranged between -5% and +10%; in other words, only concordant to near concordant grains were accepted. Furthermore, all analyses with a

common-Pb contamination over 1.5% were rejected. These cutoff values were selected in order to minimize the error propagation during the age calculations and to minimize uncertainties for further initial ϵHf and model age calculations. Raw U-Pb dating data can be found in Supplementary Material A.

5.2 Lu-Hf isotope system determination

The determination of the Lu-Hf isotopic measurements were performed at the GEMOC/CCFS Centre using a New Wave/Merchantek UP-213 laser-ablation microprobe, attached to a Nu Plasma multi-collector ICP-MS. The procedures and analytical conditions of the Lu-Hf-isotope analysis follow the methodology outlined in Griffin et al. (2000) and Belousova et al. (2006, 2009). The process was performed using a beam diameter between 40 to 55 μm and a repetition rate between 4 to 5 Hz, which depended on the individual grain size. The ablation time ranged between 90 and 120 seconds and produced a pit of 30 to 40 μm deep. The resulting ablated material was transported from the laser-ablation cell, passing by a mixing chamber and into the ICPMS torch by means of He gas. Ablation spots were performed over SHRIMP pits where possible.

Zircon Hf crustal model ages (T_{DM}^{C}) for host magmas are determined by projecting the $^{176}\text{Hf}/^{177}\text{Hf}$ determined value to the depleted mantle curve; this is achieved by means of using the measured $^{176}\text{Lu}/^{177}\text{Hf}$ of the zircon (TDM; a minimum model age), or an assumed value for the $^{176}\text{Lu}/^{177}\text{Hf}$ of the protolith (O'Reilly et al., 2008). The crustal residence age refers to the difference between the crystallization age (e.g. U-Pb age) and Hf model ages (O'Reilly et al., 2008). Raw Lu-Hf isotope data summarize in Supplementary Material B.

6 Results

6.1 Zircon Characteristics

Three main morphological populations were identified during the hand picking process:

- (1) Elongated prismatic grains of variable size, ranging between 25-100 μm wide and 75-200 μm long, was the most abundant population, which represents approximately 65% of all the mounted zircons, where numerous grains show an oscillatory zoning. Such crystal morphology (both external and internal) suggests that these zircons are most likely of magmatic origin;
- (2) A population of sub-rounded grains that also show oscillatory zoning. The size of these grains ranges between 25 to 100 μm in diameter. However, some of these grains may have been originally elongated; it is thought that the zircons are primary igneous and possibly transported from a distant source; and
- (3) Grains with very weak zoning or not clear/diffuse zoning. This weak zoning suggests that these grains have possibly been of magmatic origin, but affected by later metamorphic event. Their external morphology is a mixture of elongated and rounded grains, where the latter are more dominant.

Regarding the coloration of the zircons, all the populations tend to be clear to semi-transparent, reddish-brown and in very rare occasions they are opaque and dark brown. The occurrence of the opaque, dark brown grains is mainly in the third population. Additional characteristics that have been considered during the selection of grains for analyses are the number of cracks and fractures as well as the degree of metamictization. Very fractured and metamict grains were avoided during the analytical work.

6.2 U-Pb dating

6.2.1 The Niger River Basin

The results for the different sample sites were grouped by sub-basins. In the case of the Niger River basin, it is represented by a single sub-basin in this study. The Yanfolila-Kalana sub-basin of the Niger River includes 4 different sampling sites: ML1-ML2-ML3 and ML4, all collected along the Guinea-Mali border. 599 zircons representative of all visible populations were mounted. Out of these grains, 295 have been analyzed for U-Pb age, of which 50 analyses were rejected on the basis of the high discordance and common-Pb component. U-Pb age probability density diagram (Figure 4) shows that around 88% of the analyses are within six major age populations ($^{207}\text{Pb}/^{206}\text{Pb}$): (1) 2083 ± 5 Ma, 19 analyses; (2) 2125 ± 3 Ma, 96 analyses; (3) 2174 ± 4 Ma, 54 analyses; (4) 2212 ± 7 Ma, 25 analyses; (5) 2248 ± 6 Ma, 9 analyses; and (6) 2678 ± 5 Ma, 7 analyses. Five out of 6 defined populations are within a relatively narrow Paleoproterozoic age interval ranging between ca. 2080 and 2250 Ma, while only one is Archean. The remaining 12% of the analyses are much older and scattered between 2718 ± 9 to 3618 ± 10 Ma, as shown in Table 2.

6.2.2 The Bani River Basin

In the case of the Bani River Basin, 2254 zircons were mounted and imaged, out of which 792 zircons were analyzed. Out of this amount, 125 zircons were large enough to allow core and rims analyses on the same grain, while another 96 zircons were analyzed only in what appear to be cores, and the remaining 571 were analyzed in the rims. The total number of data collected was 917 U-Pb analyses; 15 grains were destroyed during ablation process rendering the analysis not reliable, and a further 317 analyses were rejected due to common Pb and/or discordancy based on the values described in the U-Pb analytical methods section. U-Pb probability density diagrams for each of the eight sub-basins (Figure 5) show the following features:

- The Yanfolila west sub-basin presents 4 major age ($^{207}\text{Pb}/^{206}\text{Pb}$) peaks at 2098 ± 3 Ma

(69 analyses), 2136 ± 4 Ma (74 analyses), 2188 ± 8 Ma (34 analyses), and 2219 ± 13 Ma (26 analyses). In addition to these 4 major populations, 7 minor age groups were identified ranging between 2255 ± 15 and 3174 ± 23 Ma;

- The Yanfolila north sub-basin shows the following major peaks: 2084 ± 6 Ma (23 analyses), 2113 ± 10 Ma (15 analyses) and 2158 ± 16 Ma (12 analyses). Older ages are represented by 3 grains with ages of 2193 ± 10 , 2195 ± 12 , 2204 ± 9 and 2340 ± 14 Ma;
- The Yanfolila east sub-basin is represented by the following major population peaks: 2095 ± 4 Ma (34 analyses), 2144 ± 18 Ma (18 analyses) and 2194 ± 18 Ma (11 analyses). Also one analysis was identified outside of the previously mentioned peaks at 2807 ± 9 Ma;
- The Yanfolila south sub-basin includes the following major population peaks: 2098 ± 6 Ma (19 analyses), 2139 ± 8 Ma (20 analyses) and 2200 ± 15 Ma (6 analyses), plus one group of 4 analyses that did not form a coherent age group between 2229 ± 24 and 2279 ± 16 Ma;
- In the case of the sub-basin Morila south, 3 major population peaks can be identified at 2075 ± 8 Ma (36 analyses), 2128 ± 6 Ma (43 analyses) and 2179 ± 8 Ma (24 analyses). Additionally, 3 analyses range between 2241 ± 12 and 2254 ± 17 Ma and had a weight mean average age of 2246 ± 16 Ma;
- The Morila north sub-basin shows only 2 major peaks at 2115 ± 9 Ma (17 analyses) and 2147 ± 10 Ma (15 analyses);
- The sub-basin Morila northeast is dominated by the two peaks at 2142 ± 7 Ma (15 analyses) and 2189 ± 8 Ma (14 analyses), whereas the remaining 11 analyses range between 2206 ± 10 and 2341 ± 9 Ma;
- The most eastern sub-basin, Syama, shows a single coherent population formed by 9

analyses at 2143 ± 12 Ma, whereas other results include 2 grains at 2038 ± 10 and 2084 ± 10 Ma and 10 grains that range between 2168 ± 10 and 2432 ± 10 Ma.

Table 3 summarizes the major populations identified in each sub-basin of the Bani River Basin as well as those analyses that did not form a coherent population group. Figure 5 shows probability density diagrams for the above mentioned sub-basins. The combined age data of all eight sub-basins defined the following population peaks, as shown in Figure 6: 2085 ± 2 Ma, $2121 \pm 2161 \pm 3$ Ma, 2200 ± 4 Ma, 2253 ± 16 Ma and 2337 ± 13 Ma.

6.3 Hf-isotope data

6.3.1 The Niger River Basin

The zircons from the Yanfolila-Kalana sub-basin show a wide range in Hf-isotope composition: most of the data plot between the CHUR and DM reference lines, however some fall below the CHUR line (Figure 7). The ϵ_{Hf} values range between -12 and +10.4 with one outlier below -12. The combined dataset for the all of the sub-basin samples shows minimum and maximum crustal model ages (T_{DM}^{C}) of 1960 and 3830 Ma, and a crustal residence age that oscillates between -1670 and 166 Ma (Table 4, Figure 7).

6.3.2 The Bani River Basin

- The Yanfolila west sub-basin shows ϵ_{Hf} values mainly concentrated between -11 and +6.2. Minimum and maximum T_{DM}^{C} model ages are 2300 and 3720 Ma, and crustal residence time ranges between -1551 and 124 Ma (Table 5, Figure 8); another observation is the decreasing range of Hf-isotope composition in zircons of younger populations.
- In the case of the samples representative of the Yanfolila north sub-basin, the ϵ_{Hf}

values vary between a minimum of -17.9 and a maximum of 8.2. The minimum and maximum T_{DM}^c model ages are 2260 and 3670 Ma; and a crustal residence time ranges from -1588 and 84 Ma (Table 5, Figure 8). Also note that there is a clear trend to more evolved Hf-isotope composition (negative ϵHf) with time;

- The ϵHf values of the samples ML10 and ML14 that form the Yanfolila east sub-basin show less variation and have a minimum of -3.2 and a maximum of +5.2. The T_{DM}^c age oscillates between 2340 and 2780 Ma, while the crustal residence time varies between -685 and -141 Ma (Table 5, Figure 8). A similar trend to more evolved Hf-isotope composition with time;
- The results for the Yanfolila south sample site ML08 show that the ϵHf values range from -3.3 to +5.7, The T_{DM}^c minimum is 2270 Ma and the maximum is 2790 Ma and the corresponding crustal residence time are -690 and -118 Ma (Table 5, Figure 8);
- The Morila northeast sub-basin shows minimum and maximum ϵHf values of -3.6 and +5.9 with the T_{DM}^c ages between 2320 and 2930 Ma and crustal residence time between -611 and -89 Ma (Table 5, Figure 8);
- The Morila south sub-basin represented by sample sites ML7 and ML9 shows ϵHf values that range significantly between -25.1 and +7.5. The crustal residence time varies between -2008 and 14 Ma and T_{DM}^c ranging between 2200 and 4140 Ma (Table 5, Figure 8). In contrast to previous basins, this one shows increasing range of Hf-isotopic composition in zircons from younger populations;
- The Morila north sub-basin has ϵHf values falling in a relatively narrow range between -1.2 and +3.8. The T_{DM}^c values range between 2390 and 2670 Ma, while the crustal residence time ranges between -555 and -238 Ma (Table 5, Figure 8);
- Syama shows predominance of juvenile ϵHf values that range between 0 and +5.0 with a single outlier plotting at -8.6. Accordingly, the T_{DM}^c range predominately

between 2230 and 2800 Ma (Table 5, Figure 8).

7 Discussion

7.1 U-Pb Age data

The U-Pb age data generated from the 4 sample sites within the Kalana-Yanfolila sub basin show the following peaks of magmatic activity: 2083 ± 5 Ma ($n = 19$); 2125 ± 3 Ma ($n = 96$); 2174 ± 4 Ma ($n = 54$); 2212 ± 7 Ma ($n = 25$); 2248 ± 6 Ma ($n = 9$). These age peaks are equivalent to the data generated from the combined eight sub-basins of the Bani River: 2085 ± 2 Ma ($n = 133$), 2121 ± 2 Ma ($n = 233$); 2161 ± 3 Ma ($n = 126$), 2200 ± 4 Ma ($n = 65$), 2253 ± 16 Ma ($n = 17$) and 2337 ± 13 Ma ($n = 6$). In addition to the previously listed peaks both sub-basin show a series of small populations of zircon ages between 3700 and 2400 Ma (Figures 9).

Although more catchments were sampled along the Bani River Basin (8 catchments), the zircon morphology and characteristics as well as age peaks identified for the Niger River basin (1 catchment) are remarkably similar to the zircon and age peaks of the Bani River Basin. This similarity in the Proterozoic zircon ages suggests that both basins were subject to a similar magmatic history or have similar source rocks. The geochronological data obtained in this study indicate that the ages of the younger peaks (< 2.3 Ga) appear to be similar across the different sub-basins, as shown in Figure 9 where some of the peaks are within analytical error. This is not always the case especially across the older peaks e.g. Niger River basin peaks at 2174 ± 4 Ma, 2212 ± 7 Ma vs. Bani River basin peaks at 2161 ± 3 Ma and 2200 ± 4 Ma (Figure 9).

The granitic intrusions across the Paleoproterozoic Birimian terranes of the southern West African Craton make up to 50% of the Paleoproterozoic rock exposure in the region.

According to Lompo (2010) and references therein, these granitic intrusions were emplaced between ca. 2200-2000 Ma and the greenstone belts sensu lato were emplaced between ca. 2250-2000 Ma. Locally across southern Mali the emplacement of felsic intrusions is slightly younger and ranges between ca. 2175 and 2080 Ma (Liégeois et al., 1991 references therein; Olson et al., 1992; Feybesse et al., 2006c; Feybesse et al., 2006b; McFarlane et al., 2011) (Parra-Avila, 2015). It is important to point out that a limited number of felsic intrusions have been dated to be older than ca. 2130 Ma across southern Mali. The record of older age rocks is limited to a monzonitic orthogneiss with an age of 2150 Ma and an interpreted inherited component of 2174 Ma (Feybesse et al., 2006c; Feybesse et al., 2006b). Four other older intrusions were reported in Parra-Avila (2015) and yield ages between ca. 2150 and 2131 Ma, mainly diorites, granodiorites and granites (surface exposures). In addition to the previously mentioned samples, three drill core “porphyries” of possible volcanic origin yield ages between 2216 and 2159 Ma (Parra-Avila, 2015).

The characteristics of the dominant zircon population, represented by elongated zoned euhedral grains, and the established detrital zircon age peaks at 2080 and 2125 Ma correlate with the known felsic intrusion record across southern Mali. Regarding the 2170, 2210 and 2250 Ma detrital zircon age peaks, their source remains unclear. The current age record of felsic magmatic activity is limited to two rocks dated at ca. 2174 and 2216 Ma, which are either shallow felsic intrusions or felsic volcanics (Parra-Avila, 2015). The combination of the previously mentioned rocks and recent studies in southern Mali greenstone belts (e.g. Yanfolila, Morila and Syama) that yielded zircon ages up to 2.3 Ga (James Davis, personal communication) might explain the occurrence of detrital zircon age peaks at 2170, 2210 and 2250 Ma. Another possibility is that the current sampling in the region has not been comprehensive enough and that the current geochronological data do not represent a complete record of ages of the different rock units across southern Mali.

Even though the major age peaks identified between ca. 2.3 and 2.0 Ga are equivalent for the two basins, the minor older peaks identified between 3.6 and 2.4 Ga are different. In the case of the Niger River basin, the older group of zircons ranges between 3.6 and 2.9 Ga, while in the Bani River basin the oldest zircons range between 2.8 and 3.1 Ga. The previously reported peaks can be explained by the known ages within the Achaean Kénéma-Man domain as it is widely accepted that the Archean portion of the craton resulted from the Leonian (ca. 3.2-3.1 Ga) and Liberian (ca. 2.8-2.7 Ga) orogenic cycles (Black et al., 1980; Boher et al., 1992; Feybesse and Milési, 1994; Kouamelan et al., 1997; Egal et al., 2002; Thiéblemont et al., 2004). In addition to these, Thiéblemont et al. (2001) have reported ages as old as 3.6 Ga in the Kénéma-Man Archean domain.

Furthermore, the Discordia plots of the U-Pb data for the different peaks and for both basins show a relative large spread, which most likely represents Pb-loss. This signature can be explained as a result of several thermal events capable of affecting the zircons U-Pb record that occurred after each major identified age peak. A second possibility, involves a single thermal event that affected U-Pb system of the different age populations. This second possibility can be due to the Eburnean orogeny. It is known that the southern West African Craton and in particular the Birimian terranes of the Baoulé-Mossi domain were affected by the Eburnean orogeny at ca. 2.0 Ga. This event is largely accepted and recognized to have metamorphosed the Birimian terranes and thus could potentially be responsible for the Pb-loss interpreted as a potential metamorphic signature. However, there is no evidence for metamorphic origin of studied zircons found in terms of their Th/U ratio as all of the studied grains have Th/U above the 0.05 threshold described by Rubatto et al. (1999); Rubatto (2002).

Another proxy to evaluate the effect of or presence of metamorphic zircons is there

shape and internal structure. In the case of the zircons analyzed in the present study the greater majority were identified to have an elongated tabular shape to a more equant to sub-rounded shape. Both of these shape types are characterized by strong to diffuse oscillatory zoning which suggests that they are the result of magmatic processes rather than metamorphic ones. Only a very small group of zircons presented a very weak zoning or not clear/diffuse zoning. This weak zoning opens the window for these grains being of magmatic origin, but affected by later metamorphic event.

7.2 Hf-isotope data

The bulk of the analyzed grains across the Niger River Basin, dated between ca. 2250 and 2075 Ma, show Hf-isotope model ages that range between 2.8 and 2.1 Ga (Figure 10). This model age range is consistent with the zircon Hf-isotope model ages established for felsic intrusions in the region (Parra-Avila, 2015), where peak magmatism related to the intrusions was dated around ca. 2090 Ma and Hf-isotope model ages range between 2.7 and 2.4 Ga. In the case of the detrital zircons of this study, the ϵHf data range between -10 and 10 (Figure 10). This ϵHf range implies that it is possible that the magmatism occurring between ca. 2250 and 2075 Ma included a mixture of juvenile magmas and some older crustal component that is as old as 2.8 Ga (Figure 10).

As previously mentioned the analyzed grains in the Bani River Basin are generally younger, and the number of zircons with ages over 2.7 Ga is significantly lower than the number of Archean grains identified in the Niger River Basin. However, similarly to the Niger River Basin, the Bani River Basin presents Hf-isotope model ages as old as 3.5 Ga for a small amount of grains, while the bulk of the analyzed grains with ages between ca. 2250 and 2075 Ma have Hf-isotope model ages up to 2.8 Ga (Figure 10). Close inspection of the different sub-basins analyzed in this study shows that these older Hf model ages (> 2.8 Ga)

and U-Pb (>3.0 Ga) ages are restricted to the Yanfolila west, Yanfolila north samples in the westernmost portions of the Bani River Basin and in close proximity to the Niger River Basin sampling areas (Figure 10).

The rest of the sampled sub-basins, including Syama, Morila north, south and northeast and Yanfolila east of the Bani River show very similar behavior and overall evolution. These five catchments are defined by ages that range between ca. 2350 and 2075 Ma, with a very limited number of grains yielding older ages. The Hf model ages range from 2.9 to 2.2 Ga. The ϵHf data distribution suggests the juvenile magmatism and reworking of older crust. But the prevalence of positive ϵHf suggests that the mixture was dominated by a mantle-derived source.

It is recognized that the zircon ages and the Hf-isotope signatures can provide insights into the early evolution of the Earth crust and can be an invaluable source of information when evaluating the presence of buried older continental crust (Griffin et al., 2004). Certainly the relationship between the Archean basement and the Paleoproterozoic domain have not been fully understood, and the current general consensus is that the Birimian terranes of the Baoulé-Mossi domain, including those covering southern Mali, are the result of a period of juvenile crustal addition and have limited to non-involvement of the Archean crust component. The oldest zircon grains (4 grains total) identified in the present study along the Niger River Basin yield U-Pb ages of ca. 3.6 Ga, while 12% of the analyzed grains were older than ca. 2.7 Ga. Moreover, a small number of zircons (< 20) dated between 2.1 and 2.7 Ga have Hf model ages between 3.6 and 3.7 Ga (Figure 10), thus indicating that their source magmas could potentially be as old as 3.7 Ga. However, in southern Mali there are no known intrusions or volcanic activity older than 2.25 Ga.

Therefore, the occurrence of these older Archean U-Pb ages and Hf model ages poses

a question of the occurrence of some older continental crust fragments that have not been documented across southern Mali. The main scenarios explored in light of the present study are: (1) the presence of inherited cores within certain grains, which might be an indication of mixing between Archean crust generated during the Leonian (ca. 3.2-3.1 Ga) and Liberian (ca. 2.8-2.7 Ga) orogenic cycles and more juvenile crust; (2) the presence of older zircons, which might represent Archean grains transported from a distal source or came from metasedimentary sequences within the basin (e.g. reworked through multiple sedimentary cycles).

7.3 Geodynamic Evolution

In order to understand the geodynamic evolution of the study area it is important to differentiate between the following zircon groups: 1) grains with U-Pb ages between 2.30 and 2.0 Ga that have Hf-isotope model ages up to 2.8 Ga; and 2) grains with ages between 2.3 and 2.0 Ga and older than 2.3 Ga with Hf-isotope model ages between 2.8 and 3.6 Ga.

As discussed before, the presence of the first main group can be explained by the known magmatic activity in the area with comparable ages of the volcanic belts and similar Hf-isotope model ages as old as 2.8 Ga, as identified in a recent study of zircons from magmatic felsic intrusions (Parra-Avila, 2015). These Paleoproterozoic age zircons (ca. 2.300-2075 Ma) are characteristic of the Birimian Paleoproterozoic domain ages across the southern West African Craton. In addition to the similarity in the age distribution pattern, their Hf-isotope signatures (grains with negative ϵ_{Hf}) show a clear of older crust component. Certainly, the zircon Hf-isotope data indicate that the juvenile, mantle-derived source was the major contributor to the magmas that originated the intrusions, but also that the contribution of an older component cannot be ignored.

The provenance of detrital zircons older than 2.3 Ga with Hf model ages between 3.6 and 2.8 Ga remains a source for speculation because there is no record of these older events in the current available geochronological and isotopic data for this region. In order to elucidate this dilemma it is important to examine the morphology and shape of the analyzed zircons for identification of long-transported populations, considering the magmatic history of the region and the distance of the sampled areas to the Archean-Paleoproterozoic boundary.

1. The magmatic history of the region has been lengthy discussed and it does not appear to be a contributing factor for these grains. No intrusions or volcanic activity have been recognized to yield ages between 2.7 and 3.6 Ga. The oldest known intrusion recorded in the Baoulé-Mossi is reported in Burkina Faso to yield an age of ca. 2253 Ma (Tshibubudze et al., 2013). More importantly there is no record of zircon Hf-isotope data that suggest model ages older than 2.8 Ga in the Paleoproterozoic Baoulé-Mossi domain across southern Mali or neighboring Burkina Faso, Guinea and Côte d'Ivoire or the rest of the West African Craton. Previous publications suggest Hf-isotope model ages up to 2.5 Ga (Abati et al., 2012) and more recently up to 2.8-2.7 Ga (Parra-Avila, 2015).
2. The Paleoproterozoic-Archean boundary is currently placed approximately 80-100 km from the study area and the interaction between the two blocks is still subject of controversy. The Leonian (ca. 3.2-3.1 Ga) and Liberian (ca. 2.8-2.7-Ga) orogenic cycles are widely mentioned as being the origin of the Archean basement of the West African Craton (Black et al., 1980; Boher et al., 1992; Feybesse and Milési, 1994; Kouamelan et al., 1997; Egal et al., 2002; Thiéblemont et al., 2004). Older zircons, which have been identified from a granite-gneiss collected within the Archean Kénéma-Man domain, yield ages

of 3.5 Ga (Thiéblemont et al., 2001).

3. Regarding the zircons shape, majority of grains that show sub-rounded to rounded morphology are those that have Hf model ages >2.8 Ga (Figure 11). This observation indicate that they were most likely transported rather than been inherited. Multiple grains that were analyzed in both rims and what was suspected to be inherited cores do not show age difference and cores and rims were ages were within error of each other. Thus, no Proterozoic zircons with Archean age cores have been identified.

Based on the evidence presented here it is possible that relic crustal fragments as old as 2.8 Ga were accreted onto the Paleoproterozoic; these fragments can potentially be under Paleoproterozoic cover. Another possibility is that this relic fragments have been eroded away and/or completely reworked. Unfortunately there is no reported evidence of the presence of any older crustal fragment (>2.8 Ga) within the Paleoproterozoic Baoulé-Mossi domain other than the detrital zircons identified in the present study. However, with the presented data it is not possible to rule out that these zircons with much older Hf-isotope model ages (over 2.8 Ga) are the result of contributions of detrital zircon populations from the sedimentary package and thus the possibility that these zircons were transported from the Archean Kénéma-Man domain and went through several cycles of sedimentation.

As mentioned before the interaction and effects of the indentation or collision between the Archean into the Paleoproterozoic domains is not fully understood, it is possible that along the boundary Paleoproterozoic magmas interacted with Archean crust hence the Paleoproterozoic U-Pb age and the Hf-isotope model ages older than 2.8 Ga. Because the greater majority of the grains with Hf-isotope signature older than 2.8 Ga are rounded to sub-rounded (Figure 11), the most plausible scenario is the distal transport. The Archean-

Paleoproterozoic boundary is approximately 80-100 km from the location of sample sites from where most of the Archean grains were identified. Grains directly derived from the Archean Kénéma-Man domain have crystallization ages between 2.7 and 3.6 Ga and their Hf composition is still unknown. The puzzling occurrence of detrital zircons with Paleoproterozoic U-Pb ages but an Archean Hf-isotope model age can also be explained by a process that includes transport of grains resulting from intrusions within the Archean-Paleoproterozoic boundary.

The Paleoproterozoic age zircons have an Hf-isotope signature that clearly suggests the mixing between Depleted Mantle and older crustal fragments potentially as old as 2.8 Ga sources. Although the older Hf isotopic signature is not present in all the studied grains it still nonetheless suggests that the interaction between juvenile and older crustal components was greater than previously reported (e.g. Abouchami et al., 1990; Boher et al., 1992). This greater interaction does not preclude the transport of the older Hf-isotope model age zircons from a distal source, like the Archean Kénéma-Man Domain.

8 Conclusions

The careful analyses of over a 1000 detrital zircons provide a new insight over the evolution of the Paleoproterozoic Baoulé-Mossi domain of the West African Craton. The Baoulé-Mossi domain is regarded as the result of juvenile crust formation and reworking of older crust that has been disaggregated or considered to have an insignificant input in the formation of the domain.

The U-Pb and Hf-isotope analyses of > 1000 zircons from modern small catchments within the Niger and Bani River basins from across southern Mali within the Paleoproterozoic Baoulé-Mossi domain of the southern West African Craton provide a new

insight into the crustal evolution of the region.

- The bulk of the analyzed zircons yield Paleoproterozoic ages between 2.4 and 2.07 Ga. This age range is in agreement with the historical ages obtained from felsic and volcanic samples within the study area. Their Hf-isotope signature, which yields model ages that range between 2.1 and 2.8 Ga, is also consistent with the current level of knowledge over the Paleoproterozoic Baoulé-Mossi domain as published recently by (Abati et al., 2012) and discussed in Parra-Avila (2015). The zircons of Paleoproterozoic age are regarded as being of magmatic origin and subject to little to no metamorphic processes. Also the Paleoproterozoic age zircons highlights that they have a mostly juvenile origin and that they have mixed with a crustal source than can potentially be as old as 2.8 Ga.

- A small group of zircons, which are for the most part sub-rounded to rounded, yield U-Pb ages between 3.6 and 2.1 Ga and have an Hf-isotope signature with model ages that range between 3.6 and 2.8 Ga. This group is interpreted to be the result of transport and subject to multiple sedimentary cycles. The most likely source for the transported grains is the Archean Kénéma-Man domain. This block is at a distance that does not exceed the 100 km from the study area.

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999 **Tables, Supplementary Material & Figure captions**

1000 *Table 1 Sample distribution by basin across southern Mali. Sample highlighted in bold letters*
 1001 *represent the samples not included in the study.*

1002 *Table 2 Yanfolila-Kalan sub-basin, showing the number of total zircons analyzed as well as*

1003 *the amount of core and rims. It also includes the 6 main populations (more than 6 analyses)*
1004 *and the range for the other analysis out of the identified populations.*

1005 *Table 3 Bani River basin sampling sites, showing the number of total zircons analyzed as well*
1006 *as the amount of core and rims. It also includes main populations (more than 6 analyses) and*
1007 *the range for the other analysis out of the identified populations.*

1008 *Table 4 Niger River basin, Yanfolila-Kalana sub-basin Hf isotopic data.*

1009 *Table 5 Bani River basin, Hf isotopic data for all sampled sub-basins.*

1010 *Supplementary Material A Raw Laser Ablation U-Pb measurements.*

1011 *Supplementary Material B Raw Lu-Hf measurements.*

1012 *Figure 1 Simplified geological map of the Leo-Man rise (modified after the BRGM*
1013 *SIGAfrique map, (Milési et al., 2004) and the West African Craton (after Gueye et al., 2007).*

1014 *Figure 2 Simplified southern Mali geology (after Miller, J. WAXI II Map).*

1015 *Figure 3 Sample distribution across southern Mali by sub-basins (after USGS drainage basin*
1016 *map).*

1017 *Figure 4 Yanfolila-Kalana sub-basin age distribution, left probability density diagram, and*
1018 *right Discordia plot diagram. Color represents the different age peaks identified.*

1019 *Figure 5 Probability density (left) and Discordia plot(right) diagrams of the Bani Basin*
1020 *samples group by sub-basin. Color represents the different age peaks identified.*

1021 *Figure 6 Probability (left) and Discordia (right) plot of all the Bani basin samples combined*

- 1022 *Figure 7 ϵHf data from the Kalana-Yanfolila sub-basin, Niger River basin, southwest Mali.*
- 1023 *Color represents the different age peaks identified.*
- 1024 *Figure 8 ϵHf data from the sample sites within the Bani River basin, south Mali.*
- 1025 *Figure 9 Combined probability density plots, Niger River (left) and Bani River (right).*
- 1026 *Figure 10 Plots of $^{176}\text{Hf}/^{177}\text{Hf}$ vs. U-Pb ages of the analyzed zircons by sub-basin.*
- 1027 *Figure 11 ϵHf vs. U-Pb age in Ma showing the distribution of the angular to sub-angular*
- 1028 *grains (black circles) and the sub-rounded to rounded grains (red circles).*

West African Craton-TerraneChron sampling				
Sample ID	Latitude	Longitude	Sub-Basin	Basin
TC-ML12-01	N10° 39.617'	W08° 12.397'	Yanfolila-Kalana	Niger River
TC-ML12-02	N10° 31.588'	W08° 08.607'		
TC-ML12-03	N10° 29.235'	W08° 05.215'		
TC-ML12-04	N10°52.235'	W08° 09.616'		
TC-ML12-05	N11°12.391'	W07° 46.614'	Yanfolila west	Bani River
TC-ML12-06	N11°06.364'	W07° 40.517'		
TC-ML12-11	N10°47.995'	W07° 19.977'		
TC-ML12-12	N10°55.262'	W07° 24.435'		
TC-ML12-13	N11°22.388'	W07° 16.650'	Morila south	
TC-ML12-07	N10°28.438'	W07° 03.297'		
TC-ML12-09	N10°36.325'	W07° 09.657'	Yanfolila south	
TC-ML12-08	N10°30.153'	W07° 04.978'		
TC-ML12-10	N10°41.753'	W07° 14.291'	Yanfolila east	
TC-ML12-14	N11°24.259'	W07° 03.777'		
TC-ML12-15	N11°18.698'	W06° 51.352'	Morila north	
TC-ML12-16	N11°48.286'	W07° 30.681'	Yanfolila north	
TC-ML12-17	N11°51.527'	W07° 23.656'		
TC-ML12-18	N11°26.086'	W06° 33.131'	Morila northeast	
TC-ML12-21	N11°03.119'	W06° 07.810'	Syama	
TC-ML12-19	N11°26.871'	W06° 28.885'		
TC-ML12-20	N10°59.305'	W06° 03.825'		
TC-ML12-22	N10°53.272'	W06° 01.743'		

Sub-Basin	Zr mounted	Zr Analyzed U-Pb	Cores	Rims	Identified Populations (Age in Ma, ≥ 6 analyses)	Other Analysis Range (Age, Ma)
Yanfolila-Kalana	599	295	80	215	2083 $\pm$ 6	2718 $\pm$ 9 to 2760 $\pm$ 9
					2123 $\pm$ 2	2809 $\pm$ 10 to 2894 $\pm$ 10
					2172 $\pm$ 3	2902 $\pm$ 10 to 2998 $\pm$ 8
					2209 $\pm$ 5	3013 $\pm$ 11 to 3057 $\pm$ 10
					2260 $\pm$ 12	3167 $\pm$ 9
					2681 $\pm$ 13	3590 $\pm$ 10 to 3618 $\pm$ 10

Yanfolia-Kalana Sub-Basin

Analysis	Age	Raw Lu-Hf Data				Scherer et al., 2001 - ^{176}Lu decay constant (1.865×10^{-11})					HF Chur (t)			
Number		$^{176}\text{Hf}/^{177}\text{Hf}$	1 se	2 se	$^{176}\text{Lu}/^{177}\text{Hf}$	$^{176}\text{Yb}/^{177}\text{Hf}$	$^{176}\text{Hf}/^{177}\text{Hf}$ initial	eHF	2se	TDMcrustal	Crustal Res. (Ma)		HF Chur (t)	HFDM (t)
ML1-05	2125	0.281668	0.0000130	0.0000260	0.0006211	0.0233935	0.281642864	7.735581636	0.923154935	2.126139943	-1.139943194	0.281643379	0.28138208	0.281643379
ML1-06	2125	0.281668	0.0000130	0.0000260	0.0006211	0.0233935	0.281642864	7.735581636	0.923154935	2.126139943	-1.139943194	0.281643379	0.28138208	0.281643379
ML1-08	2125	0.281239	0.0000200	0.0000400	0.0008717	0.0376487	0.281203722	-7.868639748	1.422456278	3.0894781	-964.4781004	0.28138208	0.28138208	0.28138208
ML1-15	2125	0.281524	0.0000160	0.0000320	0.0004359	0.0191615	0.281506358	2.885058208	1.136741642	2.427153514	-302.5135142	0.28138208	0.28138208	0.28138208
ML1-19	2125	0.281297	0.0000160	0.0000320	0.0010336	0.0488354	0.281255168	-6.040575578	1.137756869	2.977543053	-852.5430533	0.28138208	0.28138208	0.28138208
ML1-20	2125	0.281542	0.0000140	0.0000280	0.0021222	0.0852491	0.281456112	1.099645515	0.994826503	2.538005201	-413.0052006	0.28138208	0.28138208	0.28138208
ML1-21	2125	0.281478	0.0000078	0.0000156	0.0006786	0.0286832	0.281450536	0.901500875	0.554271462	2.550253026	-425.2530264	0.28138208	0.28138208	0.28138208
ML1-25	2125	2.82E-01	0.0000130	0.0000260	0.0004021	0.0179122	0.281665	8.51	0.923083	2.077708	47.29	0.281643	0.281643	0.281643
ML1-31	2125	2.82E-01	0.0000140	0.0000280	0.0005997	0.0254380	0.281631	7.30	0.994210	2.153004	-28.00	0.281643	0.281643	0.281643
ML1-32	2125	2.82E-01	0.0000130	0.0000260	0.0005331	0.0228742	0.280913	-18.18	0.925552	3.716600	-1591.60	0.281643	0.281643	0.281643
ML1-42	2125	2.81E-01	0.0000130	0.0000260	0.0003643	0.0166377	0.281140	-10.12	0.924805	3.227232	-1102.23	0.281643	0.281643	0.281643
ML1-52	2125	2.82E-01	0.0000130	0.0000260	0.0004891	0.0213825	0.281489	2.28	0.923659	2.465260	-340.26	0.281643	0.281643	0.281643
ML1-54	2125	2.82E-01	0.0000110	0.0000220	0.0006056	0.0232139	0.281557	4.70	0.781368	2.314831	-189.83	0.281643	0.281643	0.281643
ML1-56	2125	2.82E-01	0.0000130	0.0000260	0.0004369	0.0158346	0.281501	2.71	0.923619	2.386111	-313.61	0.281643	0.281643	0.281643
ML1-61	2125	2.82E-01	0.0000130	0.0000260	0.0009067	0.0369060	0.281473	1.71	0.923711	2.500224	-375.22	0.281643	0.281643	0.281643
ML1-63	2125	2.81E-01	0.0000160	0.0000320	0.0011014	0.0546083	0.281272	-5.43	1.137687	2.99941	-814.94	0.281643	0.281643	0.281643
ML1-64	2125	2.82E-01	0.0000170	0.0000340	0.0008146	0.0386476	0.281473	1.70	1.207931	2.500823	-375.82	0.281643	0.281643	0.281643
ML1-01	2174	2.81E-01	0.0000160	0.0000320	0.0006632	0.0265710	0.281393	-0.02	1.137201	2.643495	-469.50	0.281606	0.281606	0.281606
ML1-02	2174	2.82E-01	0.0000160	0.0000320	0.0010866	0.0516991	0.281538	5.15	1.136614	2.323328	-149.33	0.281606	0.281606	0.281606
ML1-09	2174	2.82E-01	0.0000170	0.0000340	0.0006008	0.0259862	0.281431	1.35	1.208111	2.558759	-384.76	0.281606	0.281606	0.281606
ML1-14	2174	2.82E-01	0.0000096	0.0000192	0.0005682	0.0244765	0.281596	7.22	0.681827	2.194062	-20.06	0.281606	0.281606	0.281606
ML1-16	2174	2.81E-01	0.0000140	0.0000280	0.0012257	0.0501155	0.280902	-17.45	0.996788	3.708334	-1534.33	0.281606	0.281606	0.281606
ML1-22	2174	2.81E-01	0.0000150	0.0000300	0.0013340	0.0583982	0.281394	0.02	1.066122	2.640838	-466.84	0.281606	0.281606	0.281606
ML1-30	2174	2.82E-01	0.0000160	0.0000320	0.0009106	0.0405614	0.281574	6.44	1.136467	2.243145	-69.15	0.281606	0.281606	0.281606
ML1-39	2174	2.82E-01	0.0000170	0.0000340	0.0016821	0.0863921	0.281473	2.85	1.207930	2.465906	-291.91	0.281606	0.281606	0.281606
ML1-57	2174	2.82E-01	0.0000130	0.0000260	0.0002095	0.0946337	0.281435	1.47	0.923838	2.551056	-377.06	0.281606	0.281606	0.281606
ML1-03	2212	2.82E-01	0.0000180	0.0000360	0.0004182	0.0195226	0.281526	5.62	1.278743	2.322109	-110.11	0.281576	0.281576	0.281576
ML1-11	2212	2.81E-01	0.0000140	0.0000280	0.0009298	0.0436967	0.281389	0.73	0.995064	2.625187	-413.19	0.281576	0.281576	0.281576
ML1-17	2212	2.82E-01	0.0000120	0.0000240	0.0002077	0.0079455	0.281570	7.18	0.852363	2.225066	-13.07	0.281576	0.281576	0.281576
ML1-27	2212	2.82E-01	0.0000150	0.0000300	0.0010618	0.0474586	0.281460	3.27	1.065870	2.468026	-256.03	0.281576	0.281576	0.281576
ML1-60	2212	2.82E-01	0.0000140	0.0000280	0.0008023	0.0377716	0.281490	4.33	0.994706	2.402013	-190.01	0.281576	0.281576	0.281576
ML1-10	2248	2.82E-01	0.0000120	0.0000240	0.0006780	0.0258363	0.281503	5.62	0.852567	2.348326	-100.33	0.281548	0.281548	0.281548
ML2-10	2125	2.82E-01	0.0000180	0.0000360	0.0009295	0.0330093	0.281512	3.10	1.278807	2.414253	-289.25	0.281643	0.281643	0.281643
ML2-13	2125	2.81E-01	0.0000210	0.0000420	0.0012151	0.0706921	0.281158	-9.50	1.493823	3.189138	-1064.14	0.281643	0.281643	0.281643
ML2-25	2125	2.81E-01	0.0000130	0.0000260	0.0007350	0.0345320	0.280895	-18.83	0.925612	3.755611	-1630.61	0.281643	0.281643	0.281643
ML2-36	2125	2.82E-01	0.0000150	0.0000300	0.0007787	0.0407994	0.281488	2.25	1.065763	2.466843	-341.84	0.281643	0.281643	0.281643
ML2-47	2125	2.82E-01	0.0000150	0.0000300	0.0015744	0.0772463	0.281509	2.99	1.065684	2.421073	-296.07	0.281643	0.281643	0.281643
ML2-52	2125	2.81E-01	0.0000170	0.0000340	0.0013790	0.0698071	0.281442	0.61	1.208063	2.568575	-443.58	0.281643	0.281643	0.281643
ML2-58	2125	2.81E-01	0.0000130	0.0000260	0.0009153	0.0417986	0.281438	0.45	0.923827	2.577869	-452.87	0.281643	0.281643	0.281643
ML2-59	2125	2.81E-01	0.0000190	0.0000380	0.0005947	0.0283380	0.280877	-19.48	1.352906	3.794904	-1669.90	0.281643	0.281643	0.281643
ML2-62	2125	2.81E-01	0.0000160	0.0000320	0.0005189	0.0285072	0.281242	-6.51	1.137810	3.006215	-881.22	0.281643	0.281643	0.281643
ML2-70	2125	2.81E-01	0.0000160	0.0000320	0.0008813	0.0410988	0.281393	-1.13	1.137198	2.675727	-550.73	0.281643	0.281643	0.281643
ML2-74	2125	2.82E-01	0.0000160	0.0000320	0.0007867	0.0354784	0.281517	3.27	1.136698	2.403728	-278.73	0.281643	0.281643	0.281643
ML2-78	2125	2.81E-01	0.0000200	0.0000400	0.0017528	0.0904097	0.281314	-3.95	1.421898	2.849105	-724.11	0.281643	0.281643	0.281643
ML2-03	2174	2.81E-01	0.0000170	0.0000340	0.0004168	0.0191713	0.281077	-11.25	1.209634	3.331846	-1157.85	0.281606	0.281606	0.281606
ML2-04	2174	2.81E-01	0.0000250	0.0000500	0.0007445	0.0381402	0.280846	-19.44	1.780334	3.828724	-1654.72	0.281606	0.281606	0.281606
ML2-07	2174	2.81E-01	0.0000180	0.0000360	0.0006248	0.0292797	0.281458	2.06	1.279085	2.514773	-340.77	0.281606	0.281606	0.281606
ML2-54	2174	2.82E-01	0.0000150	0.0000300	0.0011662	0.0541106	0.281458	2.29	1.065880	2.500313	-326.31	0.281606	0.281606	0.281606
ML2-68	2174	2.81E-01	0.0000150	0.0000300	0.0012369	0.0687808	0.281344	-1.76	1.066311	2.750389	-576.39	0.281606	0.281606	0.281606

Analysis	Age	Raw Lu-Hf Data				Scherer et al., 2001 - ^{176}Lu decay constant (1.865×10^{-11})				Crustal Res. (Ma)	Hf Chur (t)	HfDM (t)
Number	(Ma)	$^{176}\text{Hf}/^{177}\text{Hf}$	1 se	2 se	$^{176}\text{Lu}/^{177}\text{Hf}$	$^{176}\text{Yb}/^{177}\text{Hf}$	$^{176}\text{Hf}/^{177}\text{Hf}$ initial	eHf	$^{2\sigma}$	T(DM)crustal		
ML2-73	2174	2.81E-01	0.0000170	0.0000320	0.0004470	0.0213600	0.281456	2.25	1.208002	2.502972	-328.97	0.281606
ML2-33	2212	2.81E-01	0.0000160	0.0000320	0.0009827	0.0515667	0.281269	-3.55	1.137703	2.888622	-676.62	0.281576
ML2-05	2248	2.81E-01	0.0000180	0.0000360	0.0006672	0.0336223	0.280922	-15.01	1.281493	3.615670	-367.67	0.281548
ML2-60	2248	2.82E-01	0.0000140	0.0000280	0.0004283	0.0213428	0.281567	7.89	0.994436	2.207357	40.64	0.281548
ML2-71	2248	2.81E-01	0.0000140	0.0000280	0.0015659	0.0865628	0.280822	-18.59	0.997073	3.831995	-1584.00	0.281548
ML2-45	2678	2.81E-01	0.0000140	0.0000280	0.0006867	0.0309166	0.280784	-9.91	0.997209	3.622144	-944.14	0.281214
ML2-63	3057	2.81E-01	0.0000170	0.0000340	0.0010511	0.0388819	0.280697	-4.07	1.211269	3.541773	-280917	0.280917
ML3-32	2083	2.82E-01	0.0000130	0.0000260	0.0004369	0.0158346	0.281502	1.74	0.923618	2.467125	-384.12	0.281676
ML3-57	2083	2.82E-01	0.0000140	0.0000280	0.0003420	0.0137996	0.281579	4.51	0.994391	2.295927	-212.93	0.281676
ML3-14	2125	2.81E-01	0.0000170	0.0000340	0.0006008	0.0259862	0.281432	0.23	1.208108	2.591633	-466.63	0.281643
ML3-26	2125	2.81E-01	0.0000092	0.0000184	0.0012475	0.0618093	0.281393	-1.16	0.653891	2.677529	-552.53	0.281643
ML3-39	2125	2.82E-01	0.0000140	0.0000280	0.0007355	0.0273178	0.281489	2.28	0.994709	2.465199	-340.20	0.281643
ML3-42	2125	2.81E-01	0.0000120	0.0000240	0.0009051	0.0394139	0.281431	0.22	0.852783	2.592328	-467.33	0.281643
ML3-47	2125	2.81E-01	0.0000150	0.0000300	0.0006332	0.0277386	0.281420	-0.17	1.066021	2.616454	-491.45	0.281643
ML3-54	2125	2.82E-01	0.0000160	0.0000320	0.0010866	0.0516991	0.281539	4.05	1.136610	2.355555	-230.55	0.281643
ML3-55	2125	2.81E-01	0.0000160	0.0000320	0.0011014	0.0546083	0.281272	-5.43	1.137687	2.939941	-814.94	0.281643
ML3-56	2125	2.81E-01	0.0000120	0.0000240	0.0004771	0.0216627	0.281449	0.84	0.852731	2.554300	-429.30	0.281643
ML3-62	2125	2.82E-01	0.0000130	0.0000260	0.0006211	0.0233935	0.281643	7.74	0.923155	2.126140	-1.14	0.281643
ML3-04	2174	2.81E-01	0.0000096	0.0000192	0.0007903	0.0348587	0.281462	2.46	0.682152	2.490250	-316.25	0.281606
ML3-21	2174	2.82E-01	0.0000110	0.0000220	0.0006056	0.0232139	0.281557	5.82	0.781370	2.281528	-107.53	0.281606
ML3-43	2174	2.81E-01	0.0000120	0.0000240	0.0019752	0.1076800	0.281277	-4.12	0.8553251	2.895984	-721.98	0.281606
ML3-48	2174	2.81E-01	0.0000200	0.0000400	0.0008717	0.0376487	0.281203	-6.76	1.422460	3.057949	-883.95	0.281606
ML3-50	2174	2.82E-01	0.0000140	0.0000280	0.0021222	0.0852491	0.281454	2.17	0.994834	2.508234	-334.23	0.281606
ML3-51	2174	2.82E-01	0.0000130	0.0000260	0.0004891	0.0213825	0.281489	3.40	0.923660	2.431952	-257.95	0.281606
ML3-64	2174	2.82E-01	0.0000130	0.0000260	0.0006211	0.0233935	0.281642	8.85	0.923157	2.092569	81.43	0.281606
ML3-63	2212	2.81E-01	0.0000160	0.0000320	0.0006632	0.0265710	0.281392	0.84	1.137203	2.618064	-406.06	0.281576
ML3-28	2248	2.82E-01	0.0000180	0.0000360	0.0004182	0.0195226	0.281526	6.44	1.278745	2.297176	-49.18	0.281548
ML4-18	2125	2.81E-01	0.0000110	0.0000220	0.0010628	0.0507784	0.281449	0.85	0.781669	2.533655	-428.66	0.281643
ML4-33	2125	2.82E-01	0.0000150	0.0000300	0.0005487	0.0230687	0.281581	5.53	1.065414	2.263398	-138.40	0.281643
ML4-37	2125	2.82E-01	0.0000075	0.0000150	0.0004843	0.0181352	0.281577	5.41	0.532713	2.270887	-145.89	0.281643
ML4-45	2125	2.82E-01	0.0000130	0.0000260	0.0009536	0.0425794	0.281492	2.39	0.923648	2.458217	-333.22	0.281643
ML4-46	2125	2.82E-01	0.0000390	0.0000780	0.0010562	0.0544001	0.281718	10.41	2.768724	1.958944	166.06	0.281643
ML4-51	2125	2.81E-01	0.0000160	0.0000320	0.0011057	0.0536499	0.281453	1.00	1.136956	2.544291	-419.29	0.281643
ML4-56	2125	2.82E-01	0.0000150	0.0000300	0.0006920	0.0264162	0.281489	2.27	1.065761	2.465729	-340.73	0.281643
ML4-22	2174	2.82E-01	0.0000090	0.0000180	0.0011536	0.0417886	0.281526	4.73	0.639372	2.349318	-175.32	0.281606
ML4-26	2174	2.81E-01	0.0000130	0.0000260	0.0005977	0.0233166	0.281454	2.17	0.923774	2.507907	-333.91	0.281606
ML4-47	2174	2.82E-01	0.0000096	0.0000192	0.0009846	0.0428712	0.281597	7.25	0.681825	2.192404	-18.40	0.281606
ML4-49	2174	2.82E-01	0.0000110	0.0000220	0.0006405	0.0306149	0.281521	4.56	0.781468	2.359789	-185.79	0.281606
ML4-50	2174	2.81E-01	0.0000110	0.0000220	0.0004375	0.0208004	0.281451	2.05	0.781664	2.515301	-341.30	0.281606

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Analysis Number	Age (Ma)	Raw Lu-Hf Data				Scherer et al., 2001 - 176Lu decay constant (1.865x10-11)							
		176Hf/177Hf	1 se	2 se	176Lu/177Hf	176Yb/177Hf	176Hf/177Hf initial	epsilon Hf	2se	T(DM)crustal	Crustal Res. (Ma)	Hf Chur (t)	Hf DM (t)
ML5-53	2098	2.81E-01	1.30E-05	0.000026	0.000753	3.62E-02	0.281409	-1.20	0.923922	2.66	-562	0.281400	0.281664
ML5-01	2136	2.82E-01	1.60E-05	0.000032	0.000436	1.92E-02	0.281506	3.14	1.136742	2.42	-284	0.281375	0.281635
ML5-02	2136	2.82E-01	1.50E-05	0.000030	0.001062	4.75E-02	0.281462	1.56	1.065864	2.52	-382	0.281375	0.281635
ML5-06	2136	2.82E-01	1.90E-05	0.000038	0.003647	1.65E-01	0.281381	-1.33	1.350484	2.70	-560	0.281375	0.281635
ML5-29	2136	2.82E-01	1.10E-05	0.000022	0.000368	1.69E-02	0.281529	3.95	0.281447	2.37	-234	0.281375	0.281635
ML5-26	2177	2.81E-01	1.60E-05	0.000032	0.001034	4.88E-02	0.281254	-4.87	1.137761	2.94	-767	0.281347	0.281603
ML5-51	2177	2.82E-01	1.70E-05	0.000034	0.000383	1.71E-02	0.281499	3.84	1.207819	2.41	-230	0.281347	0.281603
ML5-49	2228	2.81E-01	1.70E-05	0.000034	0.000417	1.92E-02	0.281076	-10.01	1.209636	3.30	-1068	0.281313	0.281564
ML5-54	2228	2.82E-01	1.20E-05	0.000024	0.000506	2.06E-02	0.281531	6.17	0.852480	2.30	-71	0.281313	0.281564
ML5-28	2347	2.81E-01	1.30E-05	0.000026	0.000364	1.66E-02	0.281139	-5.02	0.924810	3.08	-732	0.281234	0.281472
ML5-62	3174	2.81E-01	1.30E-05	0.000026	0.000734	3.52E-02	0.280881	5.25	0.925658	3.05	124	0.280675	0.280825
ML6-01	2136	2.81E-01	1.80E-05	0.000036	0.000667	3.36E-02	0.280924	-17.56	1.281486	3.69	-1551	0.281375	0.281635
ML6-10	2136	2.82E-01	1.80E-05	0.000036	0.000930	3.30E-02	0.281512	3.35	1.278808	2.41	-271	0.281375	0.281635
ML6-15	2136	2.81E-01	1.60E-05	0.000032	0.001875	9.60E-02	0.281350	-2.43	1.137375	2.76	-628	0.281375	0.281635
ML6-27	2136	2.81E-01	1.60E-05	0.000032	0.000642	3.05E-02	0.281459	1.45	1.136933	2.52	-388	0.281375	0.281635
ML6-31	2136	2.81E-01	1.70E-05	0.000034	0.001379	6.98E-02	0.281442	0.85	1.208065	2.56	-426	0.281375	0.281635
ML6-03	2177	2.81E-01	1.80E-05	0.000036	0.000625	2.93E-02	0.281451	2.13	1.279086	2.51	-336	0.281347	0.281603
ML6-11	2177	2.81E-01	2.10E-05	0.000042	0.001215	7.07E-02	0.281157	-8.34	1.493829	3.16	-980	0.281347	0.281603
ML6-28	2177	2.81E-01	1.30E-05	0.000026	0.000735	3.45E-02	0.280895	-17.65	0.925614	3.72	-1546	0.281347	0.281603
ML6-38	2177	2.82E-01	1.50E-05	0.000030	0.000779	4.08E-02	0.281488	3.43	1.065766	2.43	-255	0.281347	0.281603
ML6-40	2177	2.81E-01	1.20E-05	0.000024	0.000480	2.14E-02	0.281337	-1.92	0.853069	2.76	-586	0.281347	0.281603
ML6-51	2177	2.82E-01	1.50E-05	0.000030	0.001574	7.72E-02	0.281508	4.14	1.065690	2.39	-211	0.281347	0.281603
ML6-37	3006	2.81E-01	1.30E-05	0.000026	0.000585	2.77E-02	0.280778	-2.39	0.925998	3.40	-395	0.280789	0.280957
ML11-02	2098	0.281435	0.000025	0.000050	0.000695	0.026779	0.281407	-1.26	1.776784	2.66	-566	0.281400	0.281664
ML11-12	2098	0.281508	0.000021	0.000042	0.000715	0.022617	0.281479	1.30	1.492116	2.51	-408	0.281400	0.281664
ML11-16	2098	0.281517	0.000019	0.000038	0.000439	0.014468	0.281499	2.01	1.349914	2.46	-364	0.281400	0.281664
ML11-27	2098	0.281509	0.000021	0.000042	0.000813	0.030196	0.281477	1.20	1.492131	2.51	-414	0.281400	0.281664
ML11-36	2098	0.281546	0.000021	0.000042	0.000841	0.035070	0.281512	2.47	1.491941	2.43	-335	0.281400	0.281664
ML11-53	2098	0.281492	0.000014	0.000028	0.000455	0.016482	0.281474	1.10	0.994764	2.52	-420	0.281400	0.281664
ML11-14	2136	0.281500	0.000024	0.000048	0.000781	0.030805	0.281468	1.78	1.705344	2.50	-368	0.281375	0.281635
ML11-15	2136	0.281532	0.000016	0.000032	0.000883	0.036192	0.281496	2.77	1.136783	2.44	-306	0.281375	0.281635
ML11-32	2136	0.281487	0.000015	0.000030	0.000651	0.025906	0.281461	1.51	1.065869	2.52	-385	0.281375	0.281635
ML11-37	2136	0.281439	0.000019	0.000038	0.000601	0.022213	0.281415	-0.12	1.350321	2.62	-486	0.281375	0.281635
ML11-40	2136	0.281590	0.000026	0.000052	0.001271	0.050189	0.281538	4.27	1.846996	2.35	-213	0.281375	0.281635
ML11-47	2136	0.281434	0.000014	0.000028	0.000484	0.014624	0.281414	-0.13	0.994974	2.62	-486	0.281375	0.281635
ML11-52	2136	0.281534	0.000027	0.000054	0.000544	0.021635	0.281512	3.34	1.918214	2.41	-272	0.281375	0.281635
ML12-18	2098	0.281459	0.000013	0.000026	0.000336	0.012731	0.281446	0.10	0.923802	2.58	-482	0.281400	0.281664
ML12-21	2098	0.281444	0.000013	0.000026	0.000656	0.025947	0.281418	-0.89	0.923893	2.64	-543	0.281400	0.281664
ML12-22	2098	0.281477	0.000008	0.000017	0.000578	0.021164	0.281454	0.40	0.589795	2.56	-464	0.281400	0.281664
ML12-28	2098	0.281464	0.000017	0.000034	0.000432	0.016037	0.281447	0.14	1.208044	2.58	-479	0.281400	0.281664
ML12-36	2098	0.281420	0.000019	0.000038	0.000435	0.017160	0.281403	-1.43	1.350378	2.67	-576	0.281400	0.281664

Analysis		Age	Raw Lu-Hf Data					Scherer et al., 2001 - ^{176}Lu decay constant (1.865×10^{-11})						
Number		(Ma)	$^{176}\text{Hf}/^{177}\text{Hf}$	1 se	2 se	$^{176}\text{Lu}/^{177}\text{Hf}$	$^{176}\text{Yb}/^{177}\text{Hf}$	$^{176}\text{Hf}/^{177}\text{Hf}$	epsilon Hf	2se	T(DM)crustal	Crustal Res. (Ma)	Hf Chur (t)	HF DM (t)
ML12-42		2098	0.281475	0.000035	0.000070	0.000838	0.020389	0.281442	-0.04	2.487195	2.59	-491	0.281400	0.281664
ML12-59		2098	0.281411	0.000014	0.000028	0.000634	0.021492	0.281386	-2.03	0.995076	2.71	-613	0.281400	0.281664
ML12-06		2136	0.281413	0.000030	0.000060	0.000812	0.031365	0.281380	-1.35	2.132348	2.70	-561	0.281375	0.281635
ML12-51		2136	0.281283	0.000076	0.000152	0.000634	0.019027	0.281257	-5.71	5.404306	2.97	-830	0.281375	0.281635
ML12-52		2136	0.281431	0.000050	0.000100	0.000879	0.025593	0.281395	-0.81	3.553720	2.66	-528	0.281375	0.281635
ML12-56		2136	0.281498	0.000014	0.000028	0.000544	0.021735	0.281476	2.06	0.994757	2.49	-351	0.281375	0.281635
ML12-57		2136	0.281474	0.000011	0.000022	0.000628	0.023816	0.281448	1.08	0.781671	2.55	-411	0.281375	0.281635
ML12-05		2177	0.281499	0.000010	0.000020	0.000532	0.019627	0.281477	3.05	0.710538	2.46	-279	0.281347	0.281603
ML12-10		2177	0.281429	0.000047	0.000094	0.000643	0.019549	0.281402	0.39	3.340413	2.62	-443	0.281347	0.281603
ML12-33		2177	0.281401	0.000020	0.000040	0.001591	0.058070	0.281335	-2.00	1.421793	2.77	-590	0.281347	0.281603
ML12-35		2177	0.281446	0.000016	0.000032	0.000541	0.020144	0.281424	1.15	1.137076	2.57	-396	0.281347	0.281603
ML12-07		2228	0.281442	0.000015	0.000030	0.000791	0.028492	0.281408	1.80	1.066066	2.57	-343	0.281313	0.281564
ML13-07		2177	0.281505	0.000041	0.000082	0.001652	0.044128	0.281436	1.61	2.913624	2.54	-368	0.281347	0.281603
ML13-08		2177	0.281501	0.000036	0.000072	0.001262	0.037724	0.281449	2.04	2.558193	2.52	-341	0.281347	0.281603
ML13-14		2177	0.281326	0.000059	0.000118	0.001068	0.029670	0.281282	-3.89	4.195083	2.88	-707	0.281347	0.281603
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ML7-38		2075	0.281395	0.000015	0.000030	0.001237	0.068781	0.281346	-3.97	1.066302	2.81	-738	0.281415	0.281682
ML7-46		2075	0.281438	0.000017	0.000034	0.001359	0.066794	0.281384	-2.61	1.208312	2.73	-655	0.281415	0.281682
ML7-05		2128	0.281506	0.000015	0.000030	0.001166	0.054111	0.281459	1.26	1.065876	2.53	-402	0.281380	0.281641
ML7-19		2128	0.281263	0.000016	0.000032	0.000519	0.028507	0.281242	-6.44	1.137810	3.00	-876	0.281380	0.281641
ML7-21		2128	0.280759	0.000017	0.000034	0.001051	0.038882	0.280716	-25.12	1.211187	4.14	-2008	0.281380	0.281641
ML7-30		2128	0.280883	0.000018	0.000036	0.000588	0.027873	0.280859	-20.04	1.281781	3.83	-1703	0.281380	0.281641
ML7-41		2128	0.280999	0.000016	0.000032	0.001438	0.065708	0.280941	-17.14	1.139030	3.66	-1528	0.281380	0.281641
ML7-43		2128	0.281000	0.000017	0.000034	0.000623	0.030072	0.280975	-15.94	1.210073	3.58	-1455	0.281380	0.281641
ML7-45		2128	0.281516	0.000014	0.000028	0.000671	0.034467	0.281489	2.33	0.994711	2.46	-336	0.281380	0.281641
ML7-47		2128	0.281429	0.000016	0.000032	0.000881	0.041099	0.281393	-1.06	1.137198	2.67	-546	0.281380	0.281641
ML9-51		2075	0.281460	0.000015	0.000030	0.000874	0.029020	0.281425	-1.15	1.066002	2.64	-565	0.281415	0.281682
ML9-63		2075	0.281560	0.000010	0.000019	0.000520	0.020024	0.281539	2.90	0.681965	2.39	-315	0.281415	0.281682
ML9-78		2075	0.281470	0.000014	0.000028	0.000973	0.028863	0.281432	-0.93	0.994913	2.63	-551	0.281415	0.281682
ML9-07		2128	0.281598	0.000017	0.000034	0.001687	0.062128	0.281530	3.78	1.207688	2.37	-246	0.281380	0.281641
ML9-08		2128	0.281454	0.000007	0.000013	0.000494	0.016872	0.281434	0.38	0.476133	2.58	-457	0.281380	0.281641
ML9-08		2128	0.281461	0.000006	0.000012	0.000477	0.016667	0.281442	0.66	0.419270	2.57	-440	0.281380	0.281641
ML9-12		2128	0.281500	0.000007	0.000014	0.000556	0.023037	0.281477	1.93	0.490270	2.49	-361	0.281380	0.281641
ML9-15		2128	0.281454	0.000013	0.000026	0.000921	0.032207	0.281417	-0.23	0.923897	2.62	-494	0.281380	0.281641
ML9-29		2128	0.281472	0.000010	0.000020	0.001008	0.034090	0.281431	0.28	0.710653	2.59	-463	0.281380	0.281641
ML9-30		2128	0.281440	0.000012	0.000024	0.000650	0.016833	0.281414	-0.34	0.852837	2.63	-501	0.281380	0.281641
ML9-33		2128	0.281482	0.000009	0.000018	0.000812	0.029781	0.281449	0.92	0.639547	2.55	-423	0.281380	0.281641
ML9-48		2128	0.281465	0.000007	0.000015	0.000933	0.037583	0.281427	0.14	0.525891	2.60	-471	0.281380	0.281641
ML9-53		2128	0.281534	0.000009	0.000018	0.000502	0.015992	0.281514	3.21	0.625192	2.41	-281	0.281380	0.281641
ML9-54		2128	0.281499	0.000012	0.000024	0.001431	0.064718	0.281441	0.63	0.852754	2.57	-441	0.281380	0.281641
ML9-55		2128	0.281520	0.000011	0.000022	0.000643	0.027140	0.281494	2.51	0.781544	2.45	-325	0.281380	0.281641
ML9-61		2128	0.281644	0.000011	0.000022	0.000911	0.036219	0.281607	6.53	0.781230	2.20	-75	0.281380	0.281641

Analysis		¹⁷⁶ Hf/ ¹⁷⁷ Hf		eHf			TDM Crustal			Crustal Residence				
Number	Std Dev.	Median	Std Dev.	Min	Max	Median	Std Dev.	Min	Max	Median	Std Dev.	Min	Max	Median
ML12-42	0.000172	0.281442	4.579521	-17.65	6.17	0.97	0.31	2.30	3.72	2.57	288	-1551	124	-417
ML12-59	0.000172	0.281442	4.579521	-17.65	6.17	0.97	0.31	2.30	3.72	2.57	288	-1551	124	-417
ML12-06	0.000172	0.281442	4.579521	-17.65	6.17	0.97	0.31	2.30	3.72	2.57	288	-1551	124	-417
ML12-51	0.000172	0.281442	4.579521	-17.65	6.17	0.97	0.31	2.30	3.72	2.57	288	-1551	124	-417
ML12-52	0.000172	0.281442	4.579521	-17.65	6.17	0.97	0.31	2.30	3.72	2.57	288	-1551	124	-417
ML12-56	0.000172	0.281442	4.579521	-17.65	6.17	0.97	0.31	2.30	3.72	2.57	288	-1551	124	-417
ML12-57	0.000172	0.281442	4.579521	-17.65	6.17	0.97	0.31	2.30	3.72	2.57	288	-1551	124	-417
ML12-05	0.000172	0.281442	4.579521	-17.65	6.17	0.97	0.31	2.30	3.72	2.57	288	-1551	124	-417
ML12-10	0.000172	0.281442	4.579521	-17.65	6.17	0.97	0.31	2.30	3.72	2.57	288	-1551	124	-417
ML12-33	0.000172	0.281442	4.579521	-17.65	6.17	0.97	0.31	2.30	3.72	2.57	288	-1551	124	-417
ML12-35	0.000172	0.281442	4.579521	-17.65	6.17	0.97	0.31	2.30	3.72	2.57	288	-1551	124	-417
ML12-07	0.000172	0.281442	4.579521	-17.65	6.17	0.97	0.31	2.30	3.72	2.57	288	-1551	124	-417
ML13-07	0.000172	0.281442	4.579521	-17.65	6.17	0.97	0.31	2.30	3.72	2.57	288	-1551	124	-417
ML13-08	0.000172	0.281442	4.579521	-17.65	6.17	0.97	0.31	2.30	3.72	2.57	288	-1551	124	-417
ML13-14	0.000172	0.281442	4.579521	-17.65	6.17	0.97	0.31	2.30	3.72	2.57	288	-1551	124	-417
Morila South Sub-Basin														
ML7-38	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML7-46	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML7-05	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML7-19	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML7-21	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML7-30	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML7-41	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML7-43	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML7-45	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML7-47	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML9-51	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML9-63	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML9-78	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML9-07	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML9-08	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML9-08	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML9-12	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML9-15	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML9-29	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML9-30	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML9-33	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML9-48	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML9-53	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML9-54	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML9-55	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385
ML9-61	0.000186	0.281458	6.858420	-25.12	7.46	1.32	0.41	2.20	4.14	2.53	423	-2008	14	-385

Analysis Number	Age (Ma)	Raw Lu-Hf Data				Scherer et al., 2001 - 176Lu decay constant (1.865x10-11)							
		¹⁷⁶ Hf/ ¹⁷⁷ Hf	1 se	2 se	¹⁷⁶ Lu/ ¹⁷⁷ Hf	¹⁷⁶ Yb/ ¹⁷⁷ Hf	¹⁷⁶ Hf/ ¹⁷⁷ Hf initial	epsilon Hf	2se	T(DM)crustal	Crustal Res. (Ma)	HF Chur (t)	HfDM (t)
ML9-66	2128	0.281553	0.000009	0.000019	0.000569	0.020980	0.281530	3.79	0.667780	2.37	-245	0.281380	0.281641
ML9-69	2128	0.281512	0.000010	0.000019	0.000594	0.024937	0.281488	2.30	0.674985	2.47	-338	0.281380	0.281641
ML9-80	2128	0.281538	0.000014	0.000028	0.001235	0.045842	0.281488	2.30	0.994714	2.47	-338	0.281380	0.281641
ML9-27	2179	0.281454	0.000015	0.000030	0.000920	0.027019	0.281416	0.92	1.066038	2.59	-410	0.281346	0.281602
ML9-28	2179	0.281458	0.000011	0.000022	0.000753	0.028141	0.281427	1.31	0.781731	2.56	-386	0.281346	0.281602
ML9-28	2179	0.281458	0.000010	0.000020	0.000745	0.028676	0.281427	1.32	0.710664	2.56	-385	0.281346	0.281602
ML9-32	2179	0.281504	0.000008	0.000016	0.001097	0.044687	0.281458	2.44	0.561362	2.50	-316	0.281346	0.281602
ML9-34	2179	0.281504	0.000015	0.000030	0.000630	0.024570	0.281478	3.13	1.065803	2.45	-273	0.281346	0.281602
ML9-36	2179	0.281516	0.000012	0.000024	0.001184	0.031801	0.281467	2.73	0.852676	2.48	-298	0.281346	0.281602
ML9-40	2179	0.281438	0.000013	0.000026	0.000692	0.024219	0.281409	0.69	0.923921	2.60	-424	0.281346	0.281602
ML9-44	2179	0.281551	0.000015	0.000030	0.000844	0.022417	0.281516	4.48	1.065659	2.37	-189	0.281346	0.281602
ML9-49	2179	0.281543	0.000012	0.000024	0.001199	0.047266	0.281493	3.67	0.852596	2.42	-240	0.281346	0.281602
ML9-50	2179	0.281543	0.000008	0.000016	0.000566	0.024882	0.281519	4.61	0.582553	2.36	-182	0.281346	0.281602
ML9-56	2179	0.281628	0.000010	0.000019	0.001918	0.083626	0.281548	5.63	0.681943	2.30	-118	0.281346	0.281602
ML9-57	2179	0.281620	0.000015	0.000030	0.001452	0.055515	0.281560	6.04	1.065493	2.27	-93	0.281346	0.281602
ML9-64	2179	0.281610	0.000008	0.000016	0.000912	0.036301	0.281572	6.48	0.575341	2.24	-65	0.281346	0.281602
ML9-67	2179	0.281677	0.000024	0.000048	0.003112	0.093402	0.281548	5.61	1.704862	2.30	-119	0.281346	0.281602
ML9-81	2179	0.281585	0.000013	0.000026	0.001499	0.059543	0.281523	4.72	0.923549	2.35	-174	0.281346	0.281602
ML9-10	2246	0.281607	0.000009	0.000019	0.001191	0.044508	0.281556	7.46	0.660615	2.23	14	0.281301	0.281550
Yantolia South													
ML8-04	2098	0.281472	0.000006	0.000013	0.000798	0.030041	0.281440	-0.09	0.454804	2.59	-494	0.281400	0.281664
ML8-08	2098	0.281635	0.000016	0.000032	0.001529	0.055875	0.281574	4.66	1.136469	2.30	-200	0.281400	0.281664
ML8-10	2098	0.281448	0.000014	0.000028	0.001784	0.065245	0.281377	-2.35	0.995107	2.73	-633	0.281400	0.281664
ML8-13	2098	0.281461	0.000012	0.000024	0.000873	0.031919	0.281426	-0.59	0.852799	2.62	-525	0.281400	0.281664
ML8-19	2098	0.281475	0.000013	0.000026	0.000768	0.022064	0.281444	0.05	0.923806	2.58	-485	0.281400	0.281664
ML8-31	2098	0.281512	0.000018	0.000036	0.000845	0.026657	0.281478	1.26	1.278962	2.51	-410	0.281400	0.281664
ML8-39	2098	0.281411	0.000016	0.000032	0.001519	0.047111	0.281350	-3.28	1.137372	2.79	-690	0.281400	0.281664
ML8-52	2098	0.281438	0.000007	0.000014	0.000369	0.014116	0.281423	-0.69	0.490365	2.63	-531	0.281400	0.281664
ML8-55	2098	0.281490	0.000007	0.000013	0.000675	0.027049	0.281463	0.72	0.468978	2.54	-444	0.281400	0.281664
ML8-02	2139	0.281595	0.000011	0.000022	0.001485	0.056810	0.281535	4.21	0.781432	2.36	-217	0.281373	0.281633
ML8-09	2139	0.281493	0.000011	0.000022	0.000976	0.042354	0.281453	1.32	0.781657	2.53	-396	0.281373	0.281633
ML8-12	2139	0.281596	0.000009	0.000018	0.001575	0.060631	0.281532	4.11	0.646463	2.36	-223	0.281373	0.281633
ML8-15	2139	0.281435	0.000010	0.000019	0.000653	0.024605	0.281408	-0.27	0.682282	2.63	-494	0.281373	0.281633
ML8-17	2139	0.281492	0.000021	0.000042	0.001427	0.045535	0.281434	0.63	1.492358	2.58	-438	0.281373	0.281633
ML8-20	2139	0.281484	0.000006	0.000011	0.000714	0.030593	0.281455	1.38	0.405038	2.53	-392	0.281373	0.281633
ML8-22	2139	0.281512	0.000010	0.000020	0.000499	0.021356	0.281492	2.69	0.710501	2.45	-311	0.281373	0.281633
ML8-28	2139	0.281556	0.000013	0.000026	0.001964	0.070836	0.281476	2.13	0.923702	2.48	-346	0.281373	0.281633
ML8-32	2139	0.281494	0.000007	0.000013	0.000741	0.026887	0.281464	1.70	0.461871	2.51	-372	0.281373	0.281633
ML8-33	2139	0.281617	0.000012	0.000024	0.001030	0.032579	0.281575	5.65	0.852348	2.27	-127	0.281373	0.281633
ML8-40	2139	0.281547	0.000010	0.000020	0.001175	0.045247	0.281499	2.95	0.710482	2.43	-295	0.281373	0.281633
ML8-42	2139	0.281595	0.000013	0.000026	0.001657	0.066675	0.281528	3.96	0.923533	2.37	-232	0.281373	0.281633
ML8-47	2139	0.281507	0.000011	0.000022	0.000837	0.025964	0.281473	2.02	0.781603	2.49	-352	0.281373	0.281633
ML8-48	2139	0.281482	0.000008	0.000017	0.000947	0.032557	0.281443	0.97	0.596923	2.56	-417	0.281373	0.281633
ML8-52	2139	0.281539	0.000008	0.000016	0.001220	0.047265	0.281489	2.60	0.554195	2.46	-316	0.281373	0.281633
ML8-01	2195	0.281564	0.000008	0.000016	0.000667	0.024750	0.281536	5.57	0.561207	2.31	-118	0.281335	0.281589
ML8-50	2195	0.281471	0.000009	0.000017	0.000971	0.040016	0.281430	1.81	0.604057	2.55	-351	0.281335	0.281589
ML8-61	2195	0.281506	0.000013	0.000026	0.001368	0.050974	0.281449	2.46	0.923792	2.51	-310	0.281335	0.281589
ML8-56	2229	0.281470	0.000007	0.000014	0.000847	0.035172	0.281434	2.73	0.504559	2.51	-285	0.281313	0.281563
ML8-64	2230	0.281527	0.000012	0.000024	0.001747	0.055208	0.281453	3.42	0.852719	2.47	-242	0.281312	0.281562

Analysis	Age (Ma)	Raw Lu-Hf Data				Scherer et al., 2001 - 176Lu decay constant (1.865×10^{-11})							
		$^{176}\text{Hf}/^{177}\text{Hf}$	1 se	2 se	$^{176}\text{Lu}/^{177}\text{Hf}$	$^{176}\text{Yb}/^{177}\text{Hf}$	$^{176}\text{Hf}/^{177}\text{Hf}$ initial	epsilon Hf	2se	T(DM)crustal	Crustal Res. (Ma)	HF Chur (t)	HFDM (t)
Morila North													
ML15-07	2112	0.281437	0.000014	0.000028	0.000890	0.030483	0.281401	-1.15	0.995021	2.67	-555	0.281391	0.281653
ML15-23	2112	0.281473	0.000012	0.000024	0.000838	0.032963	0.281439	0.20	0.852759	2.58	-472	0.281391	0.281653
ML15-25	2112	0.281538	0.000016	0.000032	0.000883	0.037538	0.281502	2.45	1.136757	2.45	-333	0.281391	0.281653
ML15-30	2112	0.281550	0.000025	0.000050	0.000739	0.029006	0.281520	3.08	1.776071	2.41	-294	0.281391	0.281653
ML15-43	2112	0.281465	0.000011	0.000022	0.000652	0.022720	0.281439	0.18	0.781697	2.59	-473	0.281391	0.281653
ML15-44	2112	0.281431	0.000015	0.000030	0.000602	0.021500	0.281407	-0.95	1.066072	2.66	-543	0.281391	0.281653
ML15-02	2147	0.281447	0.000012	0.000024	0.000690	0.021792	0.281419	0.28	0.852822	2.60	-458	0.281367	0.281626
ML15-04	2147	0.281464	0.000009	0.000017	0.000523	0.018559	0.281443	1.13	0.611137	2.55	-405	0.281367	0.281626
ML15-20	2147	0.281480	0.000014	0.000028	0.000729	0.027490	0.281450	1.40	0.994847	2.54	-389	0.281367	0.281626
ML15-32	2147	0.281526	0.000010	0.000019	0.000713	0.025713	0.281497	3.06	0.682068	2.43	-286	0.281367	0.281626
ML15-40	2147	0.281499	0.000015	0.000030	0.000703	0.026912	0.281470	2.11	1.065832	2.49	-345	0.281367	0.281626
ML15-42	2147	0.281542	0.000016	0.000032	0.000573	0.021361	0.281519	3.83	1.136692	2.39	-238	0.281367	0.281626
ML15-47	2147	0.281515	0.000015	0.000030	0.000343	0.012986	0.281501	3.20	1.065716	2.42	-277	0.281367	0.281626
ML15-54	2147	0.281519	0.000019	0.000038	0.000650	0.024668	0.281492	2.90	1.349948	2.44	-296	0.281367	0.281626
ML15-56	2147	0.281467	0.000015	0.000030	0.000438	0.016769	0.281449	1.36	1.065912	2.54	-391	0.281367	0.281626
ML15-60	2147	0.281515	0.000011	0.000022	0.000589	0.019981	0.281491	2.85	0.781553	2.45	-299	0.281367	0.281626
ML15-13	2182	0.281453	0.000023	0.000046	0.000942	0.030438	0.281414	0.92	1.634603	2.59	-409	0.281344	0.281599
ML15-10	2220	0.281449	0.000019	0.000038	0.000602	0.021910	0.281424	2.15	1.350278	2.54	-323	0.281319	0.281570
Morila Northwest													
ML18-04	2142	0.281479	0.000009	0.000019	0.001180	0.044328	0.281431	0.60	0.668015	2.58	-440	0.281371	0.281630
ML18-07	2142	0.281440	0.000016	0.000032	0.000865	0.029293	0.281405	-0.33	1.137152	2.64	-497	0.281371	0.281630
ML18-13	2142	0.281507	0.000011	0.000022	0.001627	0.050086	0.281441	0.94	0.781692	2.56	-418	0.281371	0.281630
ML18-16	2142	0.281439	0.000023	0.000046	0.000778	0.025843	0.281407	-0.24	1.634642	2.63	-491	0.281371	0.281630
ML18-20	2142	0.281446	0.000006	0.000011	0.000743	0.024965	0.281416	0.06	0.390881	2.61	-473	0.281371	0.281630
ML18-23	2142	0.281456	0.000009	0.000017	0.001005	0.025146	0.281415	0.03	0.618304	2.62	-474	0.281371	0.281630
ML18-27	2142	0.281468	0.000008	0.000017	0.000830	0.028048	0.281434	0.71	0.589836	2.57	-432	0.281371	0.281630
ML18-31	2142	0.281542	0.000007	0.000014	0.000681	0.028542	0.281514	3.56	0.511519	2.40	-256	0.281371	0.281630
ML18-42	2142	0.281496	0.000007	0.000015	0.000601	0.022621	0.281471	2.04	0.525808	2.49	-350	0.281371	0.281630
ML18-43	2142	0.281485	0.000009	0.000017	0.000659	0.024388	0.281458	1.57	0.618209	2.52	-380	0.281371	0.281630
ML18-44	2142	0.281539	0.000009	0.000019	0.000776	0.030169	0.281507	3.31	0.667833	2.41	-271	0.281371	0.281630
ML18-06	2186	0.281473	0.000009	0.000017	0.000834	0.026454	0.281438	1.88	0.618253	2.53	-349	0.281341	0.281596
ML18-22	2186	0.281427	0.000011	0.000022	0.000892	0.035289	0.281390	0.16	0.781834	2.64	-455	0.281341	0.281596
ML18-24	2186	0.281470	0.000007	0.000014	0.000581	0.023037	0.281446	2.15	0.497431	2.52	-332	0.281341	0.281596
ML18-25	2186	0.281499	0.000005	0.000010	0.000627	0.025894	0.281473	3.11	0.362379	2.46	-272	0.281341	0.281596
ML18-29	2186	0.281517	0.000008	0.000016	0.001428	0.056579	0.281458	2.57	0.568469	2.49	-306	0.281341	0.281596
ML18-33	2186	0.281419	0.000074	0.000148	0.002320	0.101122	0.281322	-2.24	5.260869	2.79	-603	0.281341	0.281596
ML18-36	2186	0.281506	0.000008	0.000016	0.001343	0.052352	0.281450	2.30	0.582697	2.51	-323	0.281341	0.281596
ML18-37	2186	0.281522	0.000013	0.000026	0.001027	0.041301	0.281479	3.34	0.923692	2.44	-258	0.281341	0.281596
ML18-52	2186	0.281558	0.000014	0.000028	0.000574	0.020439	0.281534	5.29	0.994551	2.32	-137	0.281341	0.281596
ML18-53	2186	0.281448	0.000006	0.000013	0.000694	0.024531	0.281419	1.20	0.447731	2.58	-391	0.281341	0.281596
ML18-54	2186	0.281467	0.000016	0.000032	0.001368	0.032783	0.281410	0.88	1.137131	2.60	-411	0.281341	0.281596
ML18-55	2186	0.281458	0.000021	0.000042	0.000928	0.021431	0.281419	1.21	1.492435	2.58	-390	0.281341	0.281596
ML18-56	2186	0.281553	0.000011	0.000022	0.000762	0.029212	0.281521	4.83	0.781469	2.35	-166	0.281341	0.281596

Analysis	¹⁷⁶ Hf/ ¹⁷⁷ Hf		eHf			TDM Crustal				Crustal Residence				
Number	Std Dev.	Median	Std Dev.	Min	Max	Median	Std Dev.	Min	Max	Median	Std Dev.	Min	Max	Median
Morila North														
ML15-07	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-23	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-25	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-30	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-43	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-44	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-02	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-04	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-20	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-32	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-40	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-42	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-47	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-54	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-56	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-60	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-13	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
ML15-10	0.000040	0.281450	1.474213	-1.15	3.83	1.76	0.09	2.39	2.67	2.54	94	-555	-238	-367
Morila Northwest														
ML18-04	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-07	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-13	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-16	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-20	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-23	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-27	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-31	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-42	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-43	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-44	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-06	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-22	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-24	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-25	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-29	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-33	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-36	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-37	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-52	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-53	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-54	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-55	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332
ML18-56	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129	-611	-89	-332

Analysis		Age (Ma)	Raw Lu-Hf Data				Scherer et al., 2001 - 176Lu decay constant (1.865x10-11)						
Number	¹⁷⁷ Hf/ ¹⁷⁷ Hf	1 se	2 se	¹⁷⁶ Lu/ ¹⁷⁷ Hf	¹⁷⁶ Yb/ ¹⁷⁷ Hf	¹⁷⁶ Hf/ ¹⁷⁷ Hf initial	epsilon Hf	2se	T(DM)crustal	Crustal Res. (Ma)	Hf Chur (t)	HfDM (t)	
ML18-57	0.281543	0.000006	0.000013	0.000927	0.027483	0.281504	4.23	0.447595	2.39	-203	0.281341	0.281596	
ML18-51	0.281498	0.000010	0.000020	0.001014	0.037081	0.281456	2.50	0.696379	2.48	-276	0.281328	0.281581	
ML18-17	0.281401	0.000006	0.000012	0.000407	0.012475	0.281384	0.51	0.440679	2.64	-427	0.281325	0.281578	
ML18-15	0.281502	0.000015	0.000030	0.000711	0.026952	0.281472	3.71	1.065825	2.44	-228	0.281323	0.281575	
ML18-14	0.281565	0.000013	0.000026	0.001081	0.037561	0.281519	5.87	0.923561	2.32	-89	0.281309	0.281559	
ML18-35	0.281489	0.000007	0.000013	0.000548	0.021117	0.281466	3.97	0.468974	2.43	-189	0.281303	0.281551	
ML18-30	0.281541	0.000007	0.000014	0.000952	0.032360	0.281500	5.43	0.511545	2.35	-103	0.281299	0.281547	
ML18-19	0.281413	0.000007	0.000014	0.000128	0.004545	0.281408	2.32	0.490392	2.56	-304	0.281297	0.281545	
ML18-26	0.281481	0.000008	0.000016	0.002117	0.083963	0.281390	1.70	0.575713	2.56	-271	0.281269	0.281513	
ML18-38	0.281292	0.000035	0.000070	0.001817	0.049022	0.281212	-3.63	2.489221	2.93	-611	0.281250	0.281490	
ML18-08	0.281433	0.000010	0.000020	0.001785	0.064996	0.281353	2.47	0.703742	2.61	-272	0.281238	0.281476	
Syama													
ML21-55	0.281651	0.000017	0.000034	0.000705	0.025545	0.281624	5.04	1.207285	2.23	-192	0.281440	0.281710	
ML21-18	0.281329	0.000090	0.000180	0.003829	0.105694	0.281173	-8.55	6.401760	3.14	-1002	0.281370	0.281629	
ML21-31	0.281580	0.000040	0.000080	0.001393	0.036113	0.281523	3.90	2.841685	2.38	-235	0.281370	0.281629	
ML21-40	0.281559	0.000040	0.000080	0.000622	0.023930	0.281534	4.27	2.841579	2.35	-212	0.281370	0.281629	
ML21-47	0.281462	0.000018	0.000036	0.000675	0.020165	0.281434	0.75	1.279161	2.57	-430	0.281370	0.281629	
ML21-49	0.281543	0.000009	0.000019	0.000453	0.016685	0.281524	3.95	0.660689	2.37	-232	0.281370	0.281629	
ML21-60	0.281543	0.000017	0.000034	0.000708	0.026245	0.281514	3.58	1.207755	2.40	-255	0.281370	0.281629	
ML21-48	0.281526	0.000010	0.000020	0.000578	0.021893	0.281502	3.73	0.710474	2.41	-239	0.281353	0.281610	
ML21-36	0.281555	0.000008	0.000015	0.002550	0.076272	0.281449	2.02	0.547168	2.52	-343	0.281349	0.281605	
ML21-58	0.281527	0.000012	0.000024	0.000843	0.027766	0.281492	3.61	0.852600	2.42	-244	0.281347	0.281602	
ML21-16	0.281535	0.000018	0.000036	0.000589	0.021171	0.281510	4.45	1.278816	2.38	-190	0.281341	0.281596	
ML21-46	0.281511	0.000016	0.000032	0.000551	0.021325	0.281488	4.18	1.136817	2.41	-200	0.281326	0.281578	
ML21-23	0.281310	0.000140	0.000280	0.001177	0.038006	0.281255	1.11	9.955367	2.76	-332	0.281177	0.281406	
Yanfolila East													
ML10-26	0.281564	0.000013	0.000026	0.001163	0.034985	0.281518	2.59	0.923566	2.42	-329	0.281402	0.281667	
ML10-28	0.281514	0.000007	0.000014	0.000432	0.017702	0.281497	1.85	0.511551	2.47	-375	0.281402	0.281667	
ML10-31	0.281559	0.000010	0.000020	0.000984	0.038293	0.281520	2.67	0.710430	2.42	-324	0.281402	0.281667	
ML10-32	0.281493	0.000010	0.000020	0.000908	0.039008	0.281457	0.43	0.696377	2.56	-462	0.281402	0.281667	
ML10-38	0.281479	0.000009	0.000018	0.000493	0.019663	0.281459	0.52	0.632418	2.55	-457	0.281402	0.281667	
ML10-39	0.281472	0.000015	0.000030	0.000762	0.029467	0.281442	-0.11	1.065941	2.59	-496	0.281402	0.281667	
ML10-50	0.281489	0.000021	0.000042	0.000996	0.037069	0.281449	0.16	1.492276	2.57	-479	0.281402	0.281667	
ML10-53	0.281449	0.000012	0.000024	0.000910	0.029544	0.281413	-1.14	0.852840	2.65	-559	0.281402	0.281667	
ML10-55	0.281488	0.000010	0.000020	0.000956	0.046039	0.281450	0.18	0.710606	2.57	-478	0.281402	0.281667	
ML10-60	0.281460	0.000014	0.000028	0.000811	0.025768	0.281428	-0.61	0.994927	2.62	-526	0.281402	0.281667	
ML10-71	0.281471	0.000013	0.000026	0.001131	0.039065	0.281426	-0.67	0.923867	2.63	-530	0.281402	0.281667	
ML10-72	0.281480	0.000008	0.000016	0.000441	0.016907	0.281462	0.63	0.554248	2.55	-450	0.281402	0.281667	
ML10-11	0.281495	0.000011	0.000022	0.000550	0.023136	0.281473	2.12	0.781604	2.49	-345	0.281369	0.281629	
ML10-12	0.281512	0.000010	0.000020	0.000756	0.031945	0.281481	2.43	0.710527	2.47	-326	0.281369	0.281629	
ML10-15	0.281589	0.000013	0.000026	0.001313	0.054013	0.281535	4.36	0.923507	2.35	-206	0.281369	0.281629	
ML10-45	0.281480	0.000023	0.000046	0.001379	0.053005	0.281424	0.39	1.634546	2.60	-452	0.281369	0.281629	

Analysis	¹⁷⁶ Hf/ ¹⁷⁷ Hf		eHf			TDM Crustal			Crustal Residence		
Number	Std Dev.	Median	Std Dev.	Min	Max	Median	Std Dev.	Min	Max	Min	Max
ML18-57	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129
ML18-51	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129
ML18-17	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129
ML18-15	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129
ML18-14	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129
ML18-35	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129
ML18-30	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129
ML18-19	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129
ML18-26	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129
ML18-38	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129
ML18-08	0.000063	0.281441	2.074806	-3.63	5.87	2.04	0.13	2.32	2.93	2.53	129
Syama											
ML21-55	0.000121	0.281502	3.553711	-8.55	5.04	3.73	0.23	2.23	3.14	2.41	218
ML21-18	0.000121	0.281502	3.553711	-8.55	5.04	3.73	0.23	2.23	3.14	2.41	218
ML21-31	0.000121	0.281502	3.553711	-8.55	5.04	3.73	0.23	2.23	3.14	2.41	218
ML21-40	0.000121	0.281502	3.553711	-8.55	5.04	3.73	0.23	2.23	3.14	2.41	218
ML21-47	0.000121	0.281502	3.553711	-8.55	5.04	3.73	0.23	2.23	3.14	2.41	218
ML21-49	0.000121	0.281502	3.553711	-8.55	5.04	3.73	0.23	2.23	3.14	2.41	218
ML21-60	0.000121	0.281502	3.553711	-8.55	5.04	3.73	0.23	2.23	3.14	2.41	218
ML21-48	0.000121	0.281502	3.553711	-8.55	5.04	3.73	0.23	2.23	3.14	2.41	218
ML21-36	0.000121	0.281502	3.553711	-8.55	5.04	3.73	0.23	2.23	3.14	2.41	218
ML21-58	0.000121	0.281502	3.553711	-8.55	5.04	3.73	0.23	2.23	3.14	2.41	218
ML21-16	0.000121	0.281502	3.553711	-8.55	5.04	3.73	0.23	2.23	3.14	2.41	218
ML21-46	0.000121	0.281502	3.553711	-8.55	5.04	3.73	0.23	2.23	3.14	2.41	218
ML21-23	0.000121	0.281502	3.553711	-8.55	5.04	3.73	0.23	2.23	3.14	2.41	218
Yanfolila East											
ML10-26	0.000046	0.281456	1.939933	-3.18	5.19	0.62	0.11	2.34	2.78	2.55	126
ML10-28	0.000046	0.281456	1.939933	-3.18	5.19	0.62	0.11	2.34	2.78	2.55	126
ML10-31	0.000046	0.281456	1.939933	-3.18	5.19	0.62	0.11	2.34	2.78	2.55	126
ML10-32	0.000046	0.281456	1.939933	-3.18	5.19	0.62	0.11	2.34	2.78	2.55	126
ML10-38	0.000046	0.281456	1.939933	-3.18	5.19	0.62	0.11	2.34	2.78	2.55	126
ML10-39	0.000046	0.281456	1.939933	-3.18	5.19	0.62	0.11	2.34	2.78	2.55	126
ML10-50	0.000046	0.281456	1.939933	-3.18	5.19	0.62	0.11	2.34	2.78	2.55	126
ML10-53	0.000046	0.281456	1.939933	-3.18	5.19	0.62	0.11	2.34	2.78	2.55	126
ML10-55	0.000046	0.281456	1.939933	-3.18	5.19	0.62	0.11	2.34	2.78	2.55	126
ML10-60	0.000046	0.281456	1.939933	-3.18	5.19	0.62	0.11	2.34	2.78	2.55	126
ML10-71	0.000046	0.281456	1.939933	-3.18	5.19	0.62	0.11	2.34	2.78	2.55	126
ML10-72	0.000046	0.281456	1.939933	-3.18	5.19	0.62	0.11	2.34	2.78	2.55	126
ML10-11	0.000046	0.281456	1.939933	-3.18	5.19	0.62	0.11	2.34	2.78	2.55	126
ML10-12	0.000046	0.281456	1.939933	-3.18	5.19	0.62	0.11	2.34	2.78	2.55	126
ML10-15	0.000046	0.281456	1.939933	-3.18	5.19	0.62	0.11	2.34	2.78	2.55	126
ML10-45	0.000046	0.281456	1.939933	-3.18	5.19	0.62	0.11	2.34	2.78	2.55	126

Analysis		Age (Ma)	Raw Lu-Hf Data				Scherer et al., 2001 - 176Lu decay constant (1.865x10-11)							
Number			¹⁷⁶ Hf/ ¹⁷⁷ Hf	1 se	2 se	¹⁷⁶ Lu/ ¹⁷⁷ Hf	¹⁷⁶ Yb/ ¹⁷⁷ Hf	¹⁷⁶ Hf/ ¹⁷⁷ Hf initial	epsilon Hf	2se	T(DM)crustal	Crustal Res. (Ma)	HF Chur (t)	HF DM (t)
ML10-54		2144	0.281454	0.000007	0.000015	0.000851	0.039711	0.281419	0.23	0.518799	2.61	-462	0.281369	0.281629
ML10-59		2144	0.281517	0.000009	0.000019	0.001452	0.049489	0.281458	1.60	0.660845	2.52	-377	0.281369	0.281629
ML10-63		2144	0.281491	0.000016	0.000032	0.000719	0.031322	0.281462	1.74	1.136922	2.51	-369	0.281369	0.281629
ML10-14		2194	0.281558	0.000011	0.000022	0.000760	0.031879	0.281526	5.19	0.781455	2.34	-141	0.281336	0.281590
ML10-18		2194	0.281549	0.000012	0.000024	0.000744	0.028264	0.281518	4.90	0.852521	2.35	-160	0.281336	0.281590
ML10-22		2194	0.281532	0.000011	0.000022	0.001218	0.044817	0.281481	3.59	0.781580	2.43	-241	0.281336	0.281590
ML10-36		2194	0.281494	0.000012	0.000024	0.000722	0.026286	0.281464	2.97	0.852685	2.47	-279	0.281336	0.281590
ML10-46		2194	0.281455	0.000009	0.000017	0.001016	0.041067	0.281413	1.15	0.618309	2.59	-392	0.281336	0.281590
ML10-47		2194	0.281440	0.000012	0.000024	0.001043	0.043505	0.281396	0.58	0.852889	2.62	-427	0.281336	0.281590
ML10-49		2194	0.281435	0.000010	0.000019	0.001044	0.045448	0.281391	0.40	0.675216	2.63	-438	0.281336	0.281590
ML10-61		2194	0.281489	0.000014	0.000028	0.000840	0.026966	0.281454	2.62	0.994834	2.49	-301	0.281336	0.281590
ML10-64		2194	0.281592	0.000016	0.000032	0.002341	0.097396	0.281494	4.05	1.136791	2.41	-212	0.281336	0.281590
ML14-20		2095	0.281564	0.000010	0.000020	0.000814	0.028664	0.281532	3.08	0.710400	2.39	-298	0.281402	0.281667
ML14-27		2095	0.281545	0.000010	0.000020	0.000485	0.017347	0.281526	2.87	0.703311	2.41	-311	0.281402	0.281667
ML14-33		2095	0.281430	0.000017	0.000034	0.001293	0.041670	0.281378	-2.36	1.208337	2.73	-634	0.281402	0.281667
ML14-34		2095	0.281415	0.000015	0.000030	0.000539	0.016455	0.281393	-1.82	1.066123	2.70	-601	0.281402	0.281667
ML14-38		2095	0.281436	0.000010	0.000020	0.000620	0.022899	0.281411	-1.19	0.703597	2.66	-562	0.281402	0.281667
ML14-40		2095	0.281415	0.000019	0.000038	0.001066	0.048104	0.281372	-2.57	1.350523	2.74	-647	0.281402	0.281667
ML14-41		2095	0.281503	0.000021	0.000042	0.000651	0.026719	0.281477	1.15	1.492129	2.51	-418	0.281402	0.281667
ML14-43		2095	0.281378	0.000025	0.000050	0.000570	0.019671	0.281355	-3.18	1.777113	2.78	-685	0.281402	0.281667
ML14-46		2095	0.281510	0.000019	0.000038	0.000846	0.031468	0.281476	1.12	1.350025	2.51	-420	0.281402	0.281667
ML14-49		2095	0.281508	0.000012	0.000024	0.001314	0.056025	0.281456	0.39	0.852710	2.56	-465	0.281402	0.281667
ML14-52		2095	0.281493	0.000015	0.000030	0.001013	0.041885	0.281453	0.28	1.065899	2.57	-472	0.281402	0.281667
ML14-56		2095	0.281490	0.000019	0.000038	0.000699	0.030559	0.281462	0.62	1.350093	2.55	-451	0.281402	0.281667
ML14-58		2095	0.281439	0.000017	0.000034	0.001028	0.037868	0.281398	-1.66	1.208253	2.69	-591	0.281402	0.281667
ML14-59		2095	0.281467	0.000021	0.000042	0.001119	0.041588	0.281422	-0.80	1.492419	2.63	-538	0.281402	0.281667
ML14-02		2144	0.281485	0.000007	0.000014	0.000404	0.013815	0.281469	1.98	0.511603	2.50	-354	0.281369	0.281629
ML14-06		2144	0.281543	0.000009	0.000018	0.000710	0.025289	0.281514	3.60	0.639400	2.40	-253	0.281369	0.281629
ML14-35		2144	0.281473	0.000013	0.000026	0.000985	0.036704	0.281433	0.71	0.923844	2.58	-432	0.281369	0.281629
ML14-39		2144	0.281434	0.000016	0.000032	0.000746	0.029882	0.281404	-0.33	1.137157	2.64	-496	0.281369	0.281629
ML14-42		2144	0.281444	0.000023	0.000046	0.000970	0.039260	0.281404	-0.30	1.634658	2.64	-494	0.281369	0.281629
ML14-57		2144	0.281518	0.000008	0.000016	0.001351	0.058141	0.281463	1.78	0.582670	2.51	-366	0.281369	0.281629
Yanfolila North														
ML16-55		2025	0.281474	0.000010	0.000019	0.000617	0.024305	0.281450	-1.43	0.682181	2.62	-595	0.281449	0.281721
ML16-14		2053	0.281488	0.000010	0.000020	0.000684	0.027036	0.281461	-0.39	0.710577	2.58	-524	0.281430	0.281699
ML16-60		2054	0.281498	0.000010	0.000020	0.000720	0.026000	0.281470	-0.06	0.703450	2.56	-503	0.281429	0.281698
ML16-11		2084	0.281508	0.000020	0.000040	0.000760	0.029767	0.281478	0.92	1.421071	2.52	-435	0.281409	0.281675
ML16-12		2084	0.281451	0.000010	0.000020	0.000462	0.014276	0.281433	-0.68	0.696437	2.62	-534	0.281409	0.281675
ML16-27		2084	0.280971	0.000420	0.000840	0.000608	0.028052	0.280947	-17.94	29.898891	3.67	-1588	0.281409	0.281675
ML16-31		2084	0.281467	0.000008	0.000017	0.000792	0.030286	0.281436	-0.58	0.639833	2.61	-528	0.281409	0.281675
ML16-39		2084	0.281463	0.000016	0.000032	0.000775	0.026471	0.281432	-0.70	1.137041	2.62	-535	0.281409	0.281675
ML16-40		2084	0.281486	0.000018	0.000036	0.000446	0.015462	0.281468	0.58	1.279007	2.54	-456	0.281409	0.281675
ML16-41		2084	0.281476	0.000011	0.000022	0.001414	0.058341	0.281420	-1.14	0.781750	2.65	-562	0.281409	0.281675
ML16-47		2084	0.281484	0.000055	0.000110	0.000572	0.015657	0.281461	0.33	3.908175	2.56	-471	0.281409	0.281675
ML16-61		2084	0.281493	0.000014	0.000028	0.000693	0.027547	0.281466	0.48	0.994793	2.55	-462	0.281409	0.281675

Analysis	¹⁷⁶ Hf/ ¹⁷⁷ Hf		eHf		TDM Crustal			Crustal Residence			
	Number	Std Dev.	Median	Std Dev.	Min	Max	Median	Std Dev.	Min	Max	Median
ML10-54	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML10-59	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML10-63	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML10-14	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML10-18	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML10-22	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML10-36	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML10-46	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML10-47	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML10-49	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML10-61	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML10-64	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-20	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-27	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-33	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-34	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-38	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-40	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-41	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-43	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-46	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-49	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-52	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-56	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-58	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-59	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-02	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-06	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-35	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-39	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-42	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
ML14-57	0.000046	0.281456	1.939933	0.11	2.34	2.78	2.55	126	-685	-141	-435
Yanfolia North											
ML16-55	0.000105	0.281437	3.934685	0.23	2.26	3.67	2.60	246	-1588	84	-483
ML16-14	0.000105	0.281437	3.934685	0.23	2.26	3.67	2.60	246	-1588	84	-483
ML16-60	0.000105	0.281437	3.934685	0.23	2.26	3.67	2.60	246	-1588	84	-483
ML16-11	0.000105	0.281437	3.934685	0.23	2.26	3.67	2.60	246	-1588	84	-483
ML16-12	0.000105	0.281437	3.934685	0.23	2.26	3.67	2.60	246	-1588	84	-483
ML16-27	0.000105	0.281437	3.934685	0.23	2.26	3.67	2.60	246	-1588	84	-483
ML16-31	0.000105	0.281437	3.934685	0.23	2.26	3.67	2.60	246	-1588	84	-483
ML16-39	0.000105	0.281437	3.934685	0.23	2.26	3.67	2.60	246	-1588	84	-483
ML16-40	0.000105	0.281437	3.934685	0.23	2.26	3.67	2.60	246	-1588	84	-483
ML16-41	0.000105	0.281437	3.934685	0.23	2.26	3.67	2.60	246	-1588	84	-483
ML16-47	0.000105	0.281437	3.934685	0.23	2.26	3.67	2.60	246	-1588	84	-483
ML16-61	0.000105	0.281437	3.934685	0.23	2.26	3.67	2.60	246	-1588	84	-483

Analysis	Age (Ma)	Raw Lu-Hf Data					Scherer et al., 2001 - 176Lu decay constant (1.865x10-11)						
		176Hf/177Hf	1 se	2 se	176Lu/177Hf	176Yb/177Hf	176Hf/177Hf initial	epsilon Hf	2se	T(DM)crustal	Crustal Res. (Ma)	Hf Chur (t)	Hf DM (t)
ML16-69	2084	0.281427	0.000019	0.000038	0.001793	0.065669	0.281356	-3.41	1.350603	2.79	-702	0.281409	0.281675
ML16-73	2084	0.281500	0.000012	0.000024	0.000657	0.022941	0.281474	0.78	0.852654	2.53	-443	0.281409	0.281675
ML16-76	2084	0.281419	0.000350	0.000700	0.000949	0.029794	0.281381	-2.51	24.877271	2.73	-646	0.281409	0.281675
ML16-04	2113	0.281456	0.000013	0.000026	0.000836	0.030630	0.281422	-0.38	0.923878	2.62	-507	0.281390	0.281653
ML16-21	2113	0.281434	0.000036	0.000072	0.001126	0.033867	0.281389	-1.57	2.558738	2.69	-581	0.281390	0.281653
ML16-26	2113	0.281477	0.000009	0.000017	0.000432	0.015613	0.281460	0.95	0.603994	2.54	-426	0.281390	0.281653
ML16-28	2113	0.281485	0.000160	0.000320	0.001415	0.054893	0.281428	-0.18	11.370579	2.61	-495	0.281390	0.281653
ML16-30	2113	0.281430	-----		0.000558	0.021709	0.281408	-0.90		2.65	-540	0.281390	0.281653
ML16-38	2113	0.281445	0.000017	0.000034	0.000992	0.032476	0.281405	-0.99	1.208223	2.66	-545	0.281390	0.281653
ML16-49	2113	0.281556	0.000084	0.000168	0.001072	0.026814	0.281513	2.84	5.967756	2.42	-309	0.281390	0.281653
ML16-57	2113	0.281479	0.000012	0.000024	0.000626	0.022876	0.281454	0.74	0.852715	2.55	-438	0.281390	0.281653
ML16-67	2113	0.281458	0.000044	0.000088	0.001636	0.047685	0.281392	-1.45	3.127308	2.69	-574	0.281390	0.281653
ML16-03	2145	0.281483	0.000014	0.000028	0.000526	0.020950	0.281462	1.76	0.994807	2.51	-367	0.281369	0.281628
ML16-06	2145	0.281546	0.000012	0.000024	0.000441	0.013448	0.281528	4.12	0.852491	2.37	-221	0.281369	0.281628
ML16-25	2145	0.281449	0.000010	0.000019	0.000534	0.018641	0.281427	0.54	0.682237	2.59	-443	0.281369	0.281628
ML16-32	2145	0.281567	0.000180	0.000360	0.000931	0.031334	0.281529	4.15	12.787317	2.36	-219	0.281369	0.281628
ML16-42	2145	0.281513	0.000011	0.000022	0.000930	0.034461	0.281475	2.23	0.781597	2.48	-338	0.281369	0.281628
ML16-70	2145	0.281491	0.000014	0.000028	0.000873	0.028839	0.281455	1.54	0.994829	2.53	-381	0.281369	0.281628
ML16-74	2145	0.281478	0.000017	0.000034	0.000991	0.039528	0.281438	0.90	1.208083	2.56	-420	0.281369	0.281628
ML16-34	2193	0.281436	0.000063	0.000126	0.000999	0.030899	0.281394	0.48	4.477703	2.63	-433	0.281337	0.281591
ML16-71	2195	0.281204	0.000064	0.000128	0.001259	0.036352	0.281151	-8.11	4.552708	3.16	-961	0.281335	0.281589
ML16-35	2204	0.281413	0.000019	0.000038	0.000505	0.017892	0.281392	0.65	1.350430	2.62	-420	0.281329	0.281582
ML17-11	2084	0.281508	0.000022	0.000044	0.000785	0.022662	0.281477	0.89	1.563183	2.52	-437	0.281409	0.281675
ML17-14	2084	0.281373	0.000072	0.000144	0.001147	0.031177	0.281328	-4.42	5.118589	2.85	-764	0.281409	0.281675
ML17-03	2113	0.281517	0.000098	0.000196	0.001197	0.035410	0.281469	1.27	6.963471	2.52	-405	0.281390	0.281653
ML17-17	2145	0.281268	0.000100	0.000200	0.001112	0.027671	0.281223	-6.74	7.111805	3.03	-890	0.281369	0.281628
ML17-18	2145	0.281414	0.000025	0.000050	0.001773	0.063727	0.281342	-2.51	1.777199	2.78	-630	0.281369	0.281628
ML17-01	2340	0.281565	0.000009	0.000017	0.001124	0.029797	0.281515	8.19	0.603876	2.26	84	0.281238	0.281477

Analysis	¹⁷⁶ Hf/ ¹⁷⁷ Hf		eHf			TDM Crustal			Crustal Residence			
	Number	Std Dev.	Median	Std Dev.	Min	Max	Median	Std Dev.	Min	Max	Median	Max
ML16-69	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-73	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-76	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-04	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-21	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-26	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-28	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-30	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-38	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-49	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-57	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-67	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-03	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-06	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-25	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-32	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-42	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-70	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-74	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-34	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-71	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML16-35	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML17-11	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML17-14	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML17-03	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML17-17	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML17-18	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	
ML17-01	0.000105	0.281437	0.14	0.23	2.26	3.67	2.60	246	-1588	84	-483	

Figure 1

Figure 2

Figure 3

Figure 4

YANFOLILA WEST

YANFOLILA NORTH

YANFOLILA EAST

YANFOLILA SOUTH

MORILA NORTH

MORILA NORTHEAST

MORILA SOUTH

SYAMA

Figure 6

Figure 7

Figure 8

Figure 9

Bani River Basin

Niger River Basin

Niger River Basin: Kalana-Yanfolila

Bani River Basin: All

Bani River Basin: Yanfolila West

Bani River Basin: Yanfolila North

Bani River Basin: Yanfolila East

Bani River Basin: Morila Northeast

Bani River Basin: Morila South

Bani River Basin: Morila North

Bani River Basin: Syama

Figure 11

Supplementary material A for on-line publication

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Supplementary material B for on-line publication

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