Zimbabwe's coloured gemstone endowments – A regional geological overview
by A. Mamuse¹, B.P. von der Heyden², and T. Blenkinsop³

Synopsis
Zimbabwe hosts a varied array of coloured gemstones. With the exception of emerald deposits and several world-class pegmatites, few of the gemstone occurrences have received detailed attention from the scientific or mineral exploration communities. In the present contribution we summarize the status of knowledge of the gemstone deposits and occurrences in Zimbabwe, paying particular attention to the geological settings in which they were formed. Synthesis of this regional geological approach reveals that there may be significant exploration potential for further gemstone occurrences, particularly in the extensive pegmatite fields and in Al-enriched orogenic belts that have undergone greenschist to granulite facies metamorphism. Further socio-economic and developmental initiatives will aid in optimizing the value generation from this important sub-sector.

Keywords
Zimbabwe, coloured gemstones, pegmatites.

Introduction
A gemstone is a mineral, rock, or other material that is prized for its beauty, durability, and rarity. Coloured gemstones are gemstones other than diamond (GIA, 1999); an alternative definition to the older subdivision that recognized precious (superior) versus semi-precious (inferior) gemstones (GIA, 1999; Lurie, 2000). Diamond, emerald, ruby, sapphire, and pearls were considered precious and the rest of the gemstones such as amethyst, tourmaline, aquamarine, citrine, and garnet were designated semi-precious (Lurie 2000). In the newer, preferred GIA (1999) definition, gemstones other than diamond include amber, ivory, and coral, which are organic materials (GIA, 1999; Lurie, 2000), thus gemstones need not necessarily be inorganic and crystalline.

Although Zimbabwe has a significant gemstone endowment, the country is better known for its platinum group metals, chromite, gold, diamond, and coal resources (Bartholomew 1990). There is less awareness of the country's non-diamond (coloured) gemstone endowment. A notable exception is the global acclaim of the exquisite green Sandawana emeralds, discovered in 1956 (Tyndale-Biscoe, 1968; Bartholomew, 1990), which firmly established the country as one of the emerald capitals of the world. Zimbabwean aquamarine and alexandrite have also earned global recognition, and are mentioned in international general gemmology textbooks such as Cipriani and Borelli (1986) and Read (2005). Other coloured gemstones, including amethyst, ruby, sapphire, tourmaline, garnet, citrine, and iolite, are regarded as the lesser known gemstones of Zimbabwe. Most classes of coloured gemstones, but particularly these lesser known examples, have received only cursory scientific and industrial attention. For example, a search on Scopus using keywords Zimbabwe AND gemstones returns only four results, whereas a search for Zimbabwe AND pegmatites (a major gemstone host lithology) returns 32 results – most focusing on the economically important Bikita, Kamativi, and Sandawana pegmatites.

The most extensive documentation of Zimbabwean gemstones is Hawadi and Mafara (2018), which contains fundamentals of gemmology, an alphabetical listing of the gemstones with historical production figures, geological descriptions of the occurrences, and geographic coordinates, as accumulated over the years by the Zimbabwe Geological Survey. Although this work covers most known occurrences, it does not provide a systematic overview of the regional geology or metallogeny of these deposits. Metallogeny broadly refers to the study of regional to global distributions of mineral resources in a context of petrological,
temporal, and tectonic frameworks. Because metallogenic approaches provide scientific underpinning to promote sound mineral exploration practice, their application to Zimbabwean coloured gemstone endowment is an important step towards encouraging renewed exploration activity in this neglected sector. Towards this end, the present contribution considers each of the main geological provinces within Zimbabwe in the context of its coloured gemstone endowment. Because geological provinces are characterized by discrete ages and tectonic settings, correlating these to gemstone endowment represents an important first step in forming a metallogenic understanding of the local coloured gemstone occurrences. Specific emphasis is placed on the Pfungwe and Mwami gemstone clusters, which represent rich and important gem occurrences in the Pfunzi and Magondi orogenic belts, respectively, which themselves may represent prospective metallogenic settings.

Through our insights and understanding we seek to provide a scientific basis for future exploration for new gemstone discoveries in Zimbabwe. However, for the sector to fully flourish, exploration needs to be augmented with further development of capabilities in gemmological characterization and gemstone beneficiation within the local economy. Discussion and recommendations related to these key considerations are provided in order to further promote future development of Zimbabwe's coloured gemstone exploration sector and downstream value chain.

A brief overview of the main geological provinces of Zimbabwe

Zimbabwe has a geological history that spans over 3.5 billion years (Ga), and has been recently summarized by Blenkinsop (2019), in which more extensive references can be found. Figure 1 provides an overview of the geological evolution of Zimbabwe, with more details provided in following sections devoted specifically to gemstone occurrences within the different geological provinces. Briefly, the oldest rocks on the Zimbabwe craton are found in the Tokwe and comprise Sebakwian greenstones that are older than 3.2 Ga (e.g. Moorbath, Wilson, and Cotterill. 1976). The remainder of the Archean Eon saw the development of an extensive granite-greenstone cratonic block with interspersed gneissic lithologies. The greenstone volcanosedimentary sequences comprise the Belingwean, Bulawayan, and Shamvaian Supergroups separated by marked unconformities, whereas the granitic component comprises the 2.7 Ga Sesombi Suite granites and other older granites and granitoids and the 2.6-2.54 Ga Chilimanzi Suite granites (Wilson, Nesbitt, and Fanning, 1995). The late Archean was marked by a period of compressional tectonics giving rise to the Pfunzi orogenic belt (formed during the Ngwarwe Orogeny) on the northern margin of the craton (Barton et al., 1991; Vinya et al., 2001), with the contemporaneous development of migmatic gneisses in the Northern Marginal Zone of the Limpopo Belt (Kamber and Biino, 1995). The next major geological event was the intrusion of the PGE- and chromium-rich Great, Dyke mafic-ultramafic body at 2.58 Ga (Oberthür, Davis, and Blenkinsop, 2002). This intrusion may mark the final cratonization of the Zimbabwe craton.

A period of probable rifting took place around 2.2 Ga onwards resulting in deposition of the Magondi Supergroup, which was subsequently deformed into a low-grade metasedimentary sequence during the Magondi Orogeny around 1.9 Ga (Treloar, 1988; Master, 2010). This was coeval with the development of the Triangle Shear Zone and Central Zone of the Limpopo Belt (Kamber et al., 1995). The next period of sedimentation is recorded by the Umkondo Group in the east of the country (Stocklmayer, 1981) (Figure 1). Sedimentation is constrained to around 1.1 Ga and was closely followed by the outpouring of the Umkondo Large Igneous Province (LIP) (Hanson et al., 1998). Pan-African deformation events affected Zimbabwe during the assembly of Gondwana, specifically manifesting as the Zambezi and Mozambique orogenic belts in the northern and eastern parts of the country respectively, in part overprinting the deformation incurred during the Magondi Orogeny and the much earlier Ngwarwe Orogeny (Dirks and Jelsma, 2006; Munyanyiwa et al., 1997). The final major lithostratigraphic unit is the Karoo Supergroup, which represents a significant sedimentary succession deposited prior to 180 Ma (Johnson et al., 1996). Around 180 Ma, Karoo flood basalts were extruded over large parts of the south of the country (Jourdan et al., 2005), swarms of mafic dykes, alkaline ring complexes, and other plutonic rocks were emplaced. Since then, the Zimbabwean land surface has been subject to geomorphological sculpting during formation of the so-called ‘African erosional surfaces’ (Lister, 1987) and has been covered by relatively thin veneers of Cenozoic sediment belonging to the Kalahari Group (Munyikwa et al., 2000).

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**Figure 1**—Summarized geological evolution of Zimbabwe (see text for further details)
Coloured gemstones in the major geological provinces

Figure 2 shows the distribution of the gemstone occurrences within the various geological and/or metallogenic units that make up Zimbabwe’s landmass. Metallogenic approaches have only been sparingly applied to gemstone distributions elsewhere (e.g., Chen and Xing, 2011; Miladinović et al., 2016; Li et al., 2021), and to the best of our knowledge, have not been applied to the distribution of Zimbabwean gemstones. All gemstone occurrence data (N = 173) reported herein was collated from Bartholomew (1990) and Hawadi and Mafara (2018), complemented by Cipriani and Borelli (1986) and the Gemmology Institute of America (1999) to develop the gemstones classification scheme proposed in Table I. The data is being incorporated into an interactive online map of Zimbabwe’s mineral occurrences (https://tblenkinsop.github.io/Atlas-of-Industrial-Minerals-and-Gemstones-in-Zimbabwe/).

Despite the prominence of the Great Dyke in Zimbabwean geology (in terms of both its geological uniqueness and its economic importance for chromium and PGE mining), the only recorded gemstone occurrences in the Great Dyke are those of mtorolite (a chromium-rich chalcedony) and chrysoprase (Ni-rich chalcedony). Mtorolite was named after its type locality in the Mutorashanga area in the northern part of the Great Dyke. The Umkondo Group (including the Umkondo Large Igneous Province) rocks are similarly devoid of recorded coloured gemstones, although a notable black diamond placer concentration is located in the basal conglomerates of this foreland sedimentary sequence (Bartholomew, 1990). The remainder of this section thus focuses on the geological settings in which coloured gemstones feature more prominently, viz. on the granite-greenstone cratonic block, and within the four bounding orogenic or metamorphic belts.

The granite-greenstone cratonic block

The most notable gemstone occurrences located on the southern extent of the cratonic block are clusters of emerald deposits (Figure 1), several of which have been mined and some of which are currently in production. The most famous of these is the Sandawana emerald cluster (formerly the Zeus mine) which is known internationally for its small but exceptionally bright green gemstones (Zwaan, Kanis, and Petsch, 1997; Zwaan, 2006). Emerald is the green variety of beryl (Be₃Al₂Si₆O₁₈), in which the colouration derives from incorporation of trace amounts of Cr and/or V. It is a rare mineral, since its formation requires a geochemical interaction between Cr and Be, both of which are relatively sparsely distributed in the Earth’s crust (Groat et al., 2008). Mafic, and especially ultramafic, rocks are characterized by an enrichment of Cr relative to more felsic rocks, whereas Be is typically associated with pegmatites. Since ultramafic and komatiitic rocks formed prevalently during the Archean when the Earth was hotter than today, the greenstone units of the cratonic block should be prospective for these rock types, and for emerald deposits in areas where subsequent pegmatite intrusion has occurred. This model applies to the Sandawana emerald cluster, where Zwaan (2006) suggests that shearing, hydrothermal fluid flow, and Na-F metasomatism occurred at the contact between pegmatites and komatiites during the Limpopo orogeny (a convergent event between the Zimbabwe and Kaapvaal cratons at ca. 2.6 Ga) that generated some of the world’s oldest emeralds. In the northern regions of the cratonic block, the gemstone distributions include 13 occurrences of quartz varieties, four of aquamarine, and one each of corundum, garnet, and euclase (Figure 1).
The Pfunzi Orogenic Belt: Case study using the Pfungwe gemstone cluster

Figure 3 shows the distribution of gemstone occurrences in the Pfungwe gemstone cluster, which is located within the bounds of the Pfunzi Orogenic Belt, a metacratonic margin of the Zimbabwe Craton that formed before and during the Ngarwe Orogeny (ca. 2.6 Ga; Vinyu et al., 2001). The Pfungwe cluster is located within an area spanning approximately 60 km by 40 km and is centred on a geological unit known as the Pfungwe Metamorphic Suite of the Migmatitic Gneiss Terrane (Figure 3). These rocks comprise high metamorphic grade biotite and hornblende gneisses (including paragneisses of metasedimentary origin), granitic leucogneisses, and migmatites (Barton et al., 1991). Eight deposits or occurrences (three of garnet, and one each of kyanite (Al₂SiO₅), quartz (SiO₂), ruby (Al₂O₃), sapphire (Al₂O₃), and aquamarine (Be₃Al₂Si₆O₁₈)) are contained within the Pfungwe Metamorphic Suite. Several of these gems are metamorphic minerals (e.g., garnet, kyanite, and corundum), and their presence thus highlights the importance of elevated pressure and temperature conditions associated with the development of an orogenic belt. For example, the gem corundum (ruby, sapphire) stability field occurs at pressures in excess of 3 kbar and temperatures ranging between 500°C and 800°C in silica-poor protolith rocks (Ohnenstetter, Fallick, and Fagan, 2014). The primary lithological hosts for these gemstone occurrences are the aluminous quartz-biotite gneisses (garnet, ruby, sapphire, kyanite) and pegmatites (rock crystal, aquamarine). To the east of the Pfungwe Metamorphic Suite lies the Mudzi Metamorphic Suite (Figure 3), which formed during the Ngarwe Orogeny (Barton et al., 1991; Vinyu et al., 2001), and comprises predominantly tonalitic to granitic orthogneisses (Vinyu et al., 2001). Despite having experienced similar pressure and temperature conditions during regional metamorphism, this unit is conspicuously devoid of recorded gemstones except for one sapphire and one garnet occurrence. This highlights the importance of the interplay between P-T conditions and the bulk geochemistry of the protolith rocks.

The Magondi Orogenic Belt: Case study using the Mwami gemstone cluster

The Mwami cluster of 21 known gemstone occurrences is located towards the northern extremity of Zimbabwe (Figure 1), predominantly within the metapelitic rocks of the Piriwiri Group, which forms part of the Magondi Supergroup. Figure 4 depicts the distribution of these occurrences, which fall within an area roughly 25 × 35 km. Aquamarine (Be₃Al₂Si₆O₁₈) occurrences predominate, with at least ten sites identified where beryl-bearing pegmatites crosscut a range of country rocks including staurolite, staurolite-kyanite, and sillimanite schists. These rocks also host single occurrences of topaz (Al₂SiO₄(F,OH)), euclase (BeAlSiO₄(OH)), and almandine garnet (Fe₃Al₂(SiO₄)₃). The higher metamorphic grade sillimanite gneisses to the west of the cluster show a prevalence of chrysoberyl (BeAl₂O₄) occurrences, although instances of euclase and amethyst are also noted (Figure 4). To form most of these phases, Be must be added into the system, and this is typically ascribed to pegmatite intrusions or interactions with late-stage magmatic fluids (Groat, 2008 and references therein). Field relationships suggest that the pegmatite intrusions represent the important mechanism for Be addition, and based on available geochronological data for pegmatite emplacement (1.06–0.98 Ga; Glynn, 2017), the mineralization likely occurred relatively late in the Magondi Belt’s ca. 2 Ga geological history. From the gem mineral chemistry, the other crucial element is aluminium, which is expected to be in excess in the metapelitic units of the deep-marine facies Piriiwiri Group.

Other orogenic belts: Limpopo, Zambezi, and Mozambique belts

The Limpopo Belt formed approximately contemporaneously with the northern Pfunzi Belt and relates to the convergent tectonics of the eastern part of the belt, and the garnet within a porphyroblastic granitic gneiss in the southern part of the eastern N-S arm of the suite towards the Mozambique Belt.
between the Zimbabwean cratonic block and Kaapvaal Craton around 2.77–2.57 Ga (Kamber and Biino, 1995). In southern Zimbabwe, the Limpopo Belt is subdivided into the Northern Marginal Zone and the Central Zone. The Northern Marginal Zone seemingly comprises cratonic granite-greenstone rocks that have experienced high-grade metamorphism (Blenkinsop, 2019), and is largely devoid of any coloured gem occurrences, except for three occurrences of aventurine (quartz with fuchsitic inclusions; Figure 1). The Central Zone of the Limpopo Belt comprises a variety of gneisses (Broderick, 1979) which have experienced a complex deformation history, including low-to-medium pressure granulite facies metamorphism prior to 2.56, Ga and a high-
grade tectonometamorphic overprint between 2.08 and 1.85 Ga (Holzer et al., 1998). The Central Zone hosts a variety of gem occurrences including three instances of iolite (gem cordierite: (Mg,Fe)_{2}AlSiO_{5}), one of garnet, one of epidote, two unakite (epidotitized granite) occurrences, and three gem quartz occurrences. The presence of metamorphic minerals (garnet and cordierite) and metasomatic minerals (epidote) again highlights the importance of the dynamic processes operating during orogenic belt development.

The Zambezi and Mozambique belts are Pan-African orogenic belts formed during three periods of deformation between 1 and 0.5 Ga. The Zambezi Belt is located beyond the northern margin of the Zimbabwe Craton and is separated from the Pfunzi Belt by the Basal Rushinga Intrusive Complex (approx. 830 Ma) (Vinyu et al., 1999) (Figures 2, 3). Known gemstone occurrences here are limited to aquamarine and amazonite (KAlSi_{3}O_{8}), both of which were formed in pegmatites. The Mozambique Belt occurs to the east of the Zimbabwe Craton and manifests as a sub-greenschist facies metamorphic belt in the Umkondo sedimentary sequence. This is known as the Zimbabwe facies of the Mozambique Belt and is devoid of any notable coloured gem occurrences, which can be explained in part perhaps by the fact that sub-greenschist metamorphism is not sufficient to form metamorphic gem minerals such as garnet, corundum, kyanite, sillimanite, or cordierite. Further east, the Mozambique Belt is represented by an allochthonous terrane known as the Mozambique facies, which has experienced amphibolite facies metamorphism and in which kyanite is known to be present (Watson, 1969; Blenkinsop, 2019).

Discussion

Despite the significant efforts of past workers (e.g., Hawadi and Mafara, 2018), the total coloured gemstone endowment within Zimbabwe and the prospectivity for future occurrences, remain poorly constrained. This is in part due to the limited number of dedicated exploration efforts except perhaps for pegmatites during the early phases of the nuclear era (e.g., Wiles, 1961; Gallagher, 1967, UK Atomic Energy investigations), academic investigations, and a few formal attempts to apply metallocenic principles towards understanding the local gem mineral distributions (e.g., Mugumbate, 2014). Our detailed regional geological analysis of coloured gemstone occurrences serves to improve on the current status of knowledge. Importantly, the work has highlighted two main metallocenic settings in which there is high prospectivity for discovering new gem mineral occurrences viz. pegmatite belts and orogenic belts which have experienced greenschist to granulite facies metamorphic conditions. It should also be noted that at the time of writing there was a resurgence in pegmatite exploration in Zimbabwe in the search for and characterization of lithium deposits.

Pegmatite belts

The formation of pegmatites has been ascribed to both late stage magmatic fluids derived predominantly from granitic intrusions and crustal-scale anatectic processes. These processes generally concentrate a range of rare and incompatible elements (e.g., Be, Li, Ta, and REE, among others), some of which can react to form gem quality minerals, particularly within miarolitic cavities or in reaction zones with the country rocks into which they intrude (Simmons et al., 2012; London and Kontak, 2012). Zimbabwe hosts several notable pegmatites and pegmatite belts, including Bikita the world's largest Cs and petalite deposit (Dittrich et al., 2019), Sandawana (world-class green emeralds, Zwaan et al., 1997, Zwaan, 2006), Kamativi (Sn, Ta, and Li resource, Shaw et al., 2019; Gallagher, 1975 and references therein). Generally, scientific studies focus on individual pegmatites, and even these are relatively sparsely studied in the available scientific literature. Published regional studies on pegmatite belts are similarly limited in number, the most notable being the early work by Wiles (1961) focused on the Mwami mica field in the Magondi Orogenic Belt and the investigation of Li-Be pegmatites by Gallagher (1975). This general dearth in available information is detrimental to exploration efforts to find new pegmatite-hosted coloured gem occurrences. A detailed country-wide overview study is strongly recommended (as has been done for mafic dyke swarms by Söderlund et al., 2010), which can be complemented with regional-scale studies on pegmatite prospectivity (e.g., von der Heyden et al., 2023).

Orogenic belts

Orogenic belts represent compressional zones in which pre-existing rocks undergo variable degrees of metamorphism and possible intrusion by igneous rocks and pegmatites. These belts have formed around Zimbabwe's main cratonic block during convergence events (e.g., Ngwele Orogeny (ca. 2.6 Ga), Magondi Orogeny (ca. 1.9 Ga), and the Pan-African Mozambique and Zambezi orogenies; Figure 1). This broad tectonic environment provides elevated temperature and pressure conditions which, when combined with precursor lithologies that are ‘fertile’ with respect to gem-forming elements, are highly prospective for high P-T gem minerals (e.g., corundum, garnet, cordierite). Figure 6 compares the relative proportions of the gem-forming cationic elements (normalized per unit oxygen)
between the different orogenic belts found within Zimbabwe using
the mineral stoichiometry and the number of mineral occurrences
per geological unit derived from Table I. Given that the tabulated
list of coloured gemstones is not exhaustive, the pie charts in Figure
6 should be deemed as semi-quantitative representations. The figure
highlights the importance of Al, Be, and to a lesser extent Fe in the
whole-rock chemistry of orogenic belts that are well mineralized in
coloured gemstones aside from the quartz polymorphs. High
Al contents are important for the formation of gem minerals such as
kyanite, cordierite, topaz, and ruby/sapphire, and the most fertile
rocks with respect to Al are pelitic protoliths. This is well
demonstrated by the comparisons in the Pfungwe area where the
paragneissic Pfungwe Metamorphic Suite is well endowed with gem
occurrences, whereas the adjacent and contemporaneously-formed
Muodzi orthogneisses are not mineralized. The endowments of
these ‘fertile’ orogenic belts contrast with the cratonic block where,
outside of the famous emerald clusters, most of the gem mineral
occurrences comprise relatively low-value quartz polymorphs
(Figure 6).

The importance of developing the Zimbabwean coloured
gemstone sector
Despite the prevalence of coloured gemstone occurrences discussed
above, Zimbabwe has not yet developed significant value addition
capacity in the sector. More generally, there is a disconnect
between the country’s natural mineral endowment and its mineral
beneficiation capacity. Thus Zimbabwe has yet to genuinely benefit
from its mineral resources, including coloured gemstones, and that
opportunities therein remain largely under-developed and under-
explored. With the estimation that the world produces US$2–3
billion worth of rough coloured gemstones annually (Shortell and
Irwin, 2017), mostly from developing countries in the global south
(Cross, van der Wal, and de Haan, 2010; Collet, Curtze, and Reed,
2013), these countries, including Zimbabwe, should implement
more significant value addition to claim a greater stake within the
coloured gemstones sub-sector.

Our recommendations to unlock the value of Zimbabwe’s
coloured gemstone subsector are as follows.

1. Stimulate exploration efforts to further establish the formal
   Zimbabwean gemstones sub-sector
   The current contribution suggests a regional geology
   framework that can be used in the early stages of any
   exploration initiative. This constitutes a step towards
developing a formalized metallogenic framework for
coloured gemstone exploration in Zimbabwe, and should
be followed up with dedicated ‘boots-on-the-ground’ type
exploration efforts by private companies and governmental
entities.

2. Capacity building in the small-scale coloured gemstones
   subsector
   Artisanal mining generally plays an important role in
   sustaining livelihoods within local communities in Africa
   (e.g., Hilson, 2009; Hilson and Maconachie, 2020) and
accounts for the bulk of coloured gemstone production in
Africa (Africa Union, 2009) and worldwide (Collet, Curtze,
and Reed, 2013). Small-scale miners also play a significant
role in the discovery of gemstones, which sometimes
culminates in gemstone rushes, but they are generally under-
resourced, and work intermittently or seasonally so that no
proper exploration is undertaken. Their mining methods are
not always optimal or safe. Cutting and polishing operations
(value addition), where they exist, are small informal, illicit,
or backyard operations. For these workers to optimize
their efforts, there is a need for their capacitation through
training, including fundamentals of book-keeping, geology,
gemmology, environment, and mine health and safety.

Technical support from government departments in these
fields can further enhance the safety and productivity of
small-scale gemstone mining and processing enterprises. In
Zimbabwe, marketing of gemstones has to be done via the
Minerals Marketing Corporation of Zimbabwe (MMCZ),
which also helps identify marketing opportunities for
minerals including gemstones. However, due to bureaucratic
bottlenecks and price distortions in some cases, illicit trade
in gemstones may happen outside the official channels.

3. Local gemstone value addition through cutting and polishing
   The value of Zimbabwe’s gemstone endowment can be
   further unlocked through innovative beneficiation strategies
based on greater understanding of the gemstones’ physical
characteristics. Polished gemstones carry a many-fold
value addition relative to unpolished or raw gemstones,
with some studies (Thomas, 2008) putting the value of the
gemstone embodied in the finished product (jewellery)
at 11 times that of the original rough material. However,
Zimbabwe currently lacks the required research and value-
addition capacity and the gemstones themselves are yet to
be adequately studied, profiled, quantified, and evaluated.
There is therefore need to build local capacity for modern
gemmological training, research, and value addition. This
can be initiated through collaborations with established
gemmological centres and laboratories, with clear terms
for technological transfer, including the establishment of
well-equipped gemmological research and training facilities
in Zimbabwe. The Zimbabwe School of Mines has recently
initiated gemmological training courses and has started
construction of a gemmological centre. Lessons can also
be learned from countries that have earned world acclaim
in managing their gemstone sub-sectors, such as India,
which has established itself as a world gemstone
cutting and polishing centre. Such an effort must be supported
by a dedicated marketing drive to develop a brand around
Zimbabwean polished gemstones.

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Author contributions:
AM collated the datasets and wrote a draft version of the
manuscript, BvdH wrote the final draft of the manuscript, TGB
provided project oversight and manuscript polishing. All authors
were responsible for editing and figure generation.

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documents/30995-doc-africa_mining_vision_english_1.pdf
### Table I
Classification of Zimbabwean coloured gemstones (compiled from Cipriani and Borelli (1986), Bartholomew (1990), GIA (1999) and Hawadi and Mafara (2018))

<table>
<thead>
<tr>
<th>Gemstone Group</th>
<th>Gemstone species</th>
<th>Gemstone Varieties</th>
<th>Location in Zimbabwe</th>
<th>Host geology</th>
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<tbody>
<tr>
<td>Silica</td>
<td>Quartz</td>
<td>Rock crystal</td>
<td>Masvingo, Mudzi, Mutare, Nyanga</td>
<td>Pegmatites</td>
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<td>Smoky quartz</td>
<td>Marondera, Beitbridge, Hurungwe, Gweru</td>
<td>Pegmatites</td>
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<td>Rose quartz</td>
<td>Marondera, Hurungwe, Beitbridge</td>
<td>Karoo basalt cavities (Hwange, Nyamandlovu), zoned pegmatites (Hurungwe), quartz veins in granite (Makonde)</td>
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<td>Amethyst</td>
<td>Nyamandlovu, Hurungwe, Hwange, Lupane, Makonde</td>
<td>Quartz monzonites (adamelites) Replacement of crocidolite by silica</td>
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<td>Chalcedony</td>
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<td>Zvishavane, Kwekwe</td>
<td>Karoo basalts cavities</td>
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<td>Agate</td>
<td>Nyamandlovu, Chivhu, Lupane</td>
<td>Green chalcedony in narrow veins in ultramafic rocks</td>
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<td>Miorolite</td>
<td>Mutorashanga, Mutare</td>
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<td>Carnelian</td>
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<td>Jasper</td>
<td>Hurungwe, Kwekwe, Nyamandlovu</td>
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<td>Chrysoprase</td>
<td>Great Dyke, Mutare</td>
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<td>Sard</td>
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<td>Microcline</td>
<td>Amazonite</td>
<td>Nyamandlovu, Hurungwe, Rushinga</td>
<td>Pegmatites intruding Zambesi Belt metamorphic rocks</td>
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<td>Noble orthoclase</td>
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