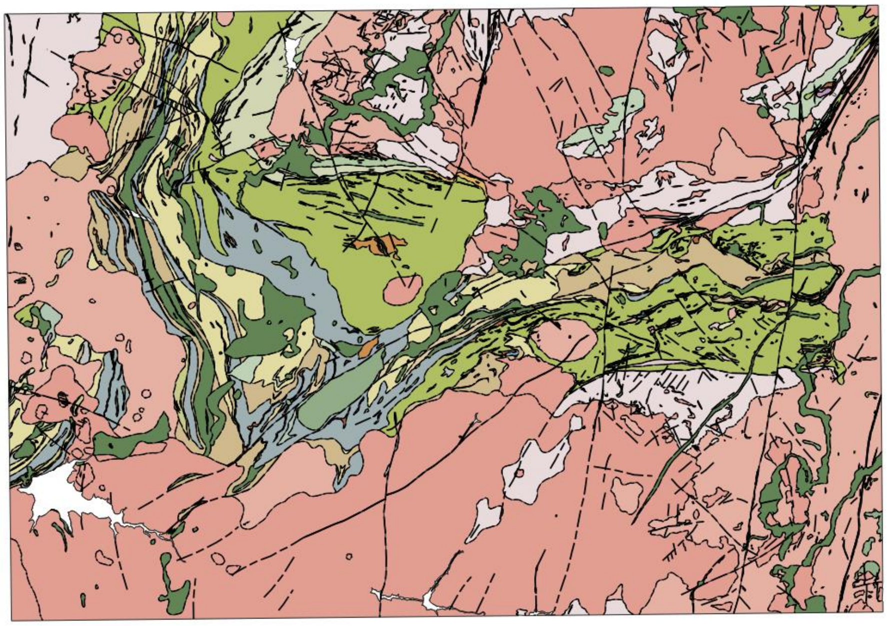
Digitisation of the 1:100k scale geological map of Harare, Zimbabwe

International Geoscience programme
Open report OR/26/047



BRITISH GEOLOGICAL SURVEY

INTERNATIONAL GEOSCIENCE PROGRAMME

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Digitisation of the 1:100k scale geological map of Harare, Zimbabwe

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Keywords

Harare; Map digitisation; Archean; Greenstone belt; Zimbabwe.

Map

Bulletin No. 94, 1:100 000 scale, Harare

Front cover

Screenshot of the digitised geological map of Harare (Baldock, 1990)
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Foreword

This open report provides contextual information for the digitised version of the 1:100k scale geological map of Harare (Baldock, 1990). Map digitisation was carried out by the British Geological Survey (BGS) as part of the project *Zimbabwe – Harare: Enhancing Resilient, Inclusive Growth through Sustainable Groundwater Management in Zimbabwe.* This project was a collaboration between BGS and the University of Zimbabwe (UZ) to support the Upper Manyame Sub-Catchment Council (UMSCC) by collating and digitising multiple groundwater datasets of the Harare area into a single GIS-based Groundwater Assessment Tool (GAT). These activities formed part of the United Kingdom (UK) Foreign and Commonwealth Development Office (FCDO) funded *Green City, Infrastructure and Energy Programme* (GCIEP), supporting progress toward climate-neutral, inclusive, and resilient urban development.

The underpinning geology was identified as a crucial part of the information to be used in the GAT, and based on discussions with project partners and stakeholders it was concluded that trust in the 1990 version of the 1:100k geological map of Harare remains high. In the absence of digital vector-format geological map data available for use for the groundwater project, the Zimbabwe Geological Survey (ZGS), the University of Zimbabwe and BGS agreed to collaborate on digitising the current 1:100k geological map. Final data ownership resides with ZGS and permission was granted for the digitised map to be used in the GAT. Simultaneous to this work, a separate team within BGS collaborated with ZGS on a second FCDO-funded project to produce a new 1:1M scale national geological map of Zimbabwe. The outputs of both projects benefitted from the synergy that resulted from this synchronicity.

Acknowledgements

The digitised map and the information in this report is the product of meetings and discussions held between the British Geological Survey (BGS), the Zimbabwe Geological Survey (ZGS), project partners (University of Zimbabwe, UZ), and collaborators/recipients of the project outputs (Upper Manyame Sub-Catchment Council, UMSCC). The authors are grateful to the Head of the Department of Construction and Civil Engineering S. Shumba of UZ, and Director F. Mugumbate and Deputy Director E. Mugandani of ZGS for their support of this project. We would further like to thank D. Mudimbu, M. Souta, O. Kativhu, R. Owen and T. Broderick for their invaluable expertise on the geology and hydrogeology of the Harare area.

The authors are also very grateful to a number of BGS staff, including J. Stevenson, J. Bow, H. E. Unwin, P. Paul, and N. Smith, who provided practical advice and critical discussions on a range of digital, geological, and cartographic topics throughout the duration of this project. Additionally, E. Unwin and P. Paul are thanked for their review of this report prior to publication.

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Summary

This report accompanies the digitised version of the geological map of Harare, Zimbabwe Geological Survey (ZGS) Bulletin Series, 1:100 000, corresponding to ZGS Bulletin No. 94. Map digitisation was carried out following the standard workflow for BGS digital map compilation with the aim to produce a ‘like-for-like’ digital copy of the paper map for the ZGS. The digitised map was converted to a QGIS-compatible GeoPackage containing layers for bedrock boundaries (line features), faults (line features), bedrock geology (polygon features) and bedrock seeds (point features).

The GIS point, line and polygon features contain attribute tables with information corresponding to the map-face labels and the legend on the paper map. Similar to the BGS data model for digital geological maps, all bedrock units were assigned a LEX-RCS code, where the LEX-part of the code contains information about the name of a geological unit and where it sits within the lithostratigraphical and lithodemic hierarchy of formation, members, groups etc., and where the RCS-part of the code contains information about the lithological composition of the unit.

Some minor modifications to the geological map were required to ‘fit’ the paper map into the output digital data model. All changes were made with the goal to keep the digital map as close to the paper version as possible. Most of these changes are minor and inconsequential to the geological information, narrative and model represented by the map. The details of the key considerations during this process and the resulting differences between the paper and digital map are recorded in this report for future reference.

1 Introduction

This report accompanies the digitised geological map of Harare (1:100 000 scale), produced by the British Geological Survey (BGS) from the Harare geological map (the ‘paper map’; Baldock, 1990). The paper map is supplemented by the accompanying Geological Survey Bulletin (No. 94; Baldock, 1991) and two interpretive cross-sections present on the map sheet (not digitised). The digitisation work formed part of the BGS activities for the groundwater project “*Zimbabwe – Harare: Enhancing Resilient, Inclusive Growth through Sustainable Groundwater Management in Zimbabwe*”, funded by the United Kingdom (UK) Foreign and Commonwealth Development Office (FCDO). Initiated as a collaboration between the University of Zimbabwe (UZ) and BGS to support the Upper Manyame Sub-Catchment Council (UMSCC), this project delivered the digitised map to the Zimbabwe Geological Survey (ZGS) and incorporated the map into a GIS-based Groundwater Assessment Tool for the Harare region, to reside with UMSCC. This project ran in parallel to a second FCDO-funded project, directed towards a BGS and ZGS collaboration to produce a new national 1:1M scale geological map of Zimbabwe. The digitised map of Harare that is the subject of this report uses and expands on the geological data model set up for the national geological map.

The digital version of the Harare map was created as a facsimile of the paper map and did not incorporate new surveying work. Nevertheless, the inherent differences in the presentation of geological data on the paper map compared to the digital map necessitated some minor changes and adaptations that were made during the digitisation process. On the paper geological map, information is conveyed by (1) the geometries of the various geological features on the map-face (e.g., bedrock units, unit boundaries, faults, structural data etc.), and (2) the map legend, which explains the meaning of the symbology and contains information on the lithological composition of units and their geological relationships. On the digitised map, the geometries of geological features on the map-face take the form of point, line and polygon GIS vector data, whereas the information in the map legend has been captured in a digital data model stored in the attribute tables of these features. In some instances, these contrasting styles of storing and conveying information caused minor issues for the digitisation process, including occurrences of (1) geological units that do not occur in the paper map legend, (2) geological units with ambiguous parent formations, and (3) omitted bedrock boundary lines. This report details the decisions and modifications made to overcome these challenges, while remaining true to the original map.

2 Digitisation method

2.1 MAP DIGITISATION

The map was digitised in ArcGIS Pro, using OpenStreetMap (available under the Open Database License) as a basemap. The scanned copy of the paper map was georeferenced to align with OpenStreetMap. Digitisation was carried out using the WGS 84 / UTM zone 36S (projected) coordinate reference system (EPSG:32736). Map digitisation was carried out following the standard BGS map compilation workflow as specified in Piper et al. (2025). In this workflow, lines are digitised first and polygons are subsequently 'built' from the intersecting linework. The various attributes of the final polygon layer are initially captured in a point-feature layer ('bedrock seeds'), consisting of one seed per polygon. The seed attributes are transferred to the polygon during the process of polygon building. The symbology of the line and polygon layers was chosen to most closely match the printed version of the Harare map sheet.

The outputs were converted to a QGIS-compatible GeoPackage that contains the following layers:

- **Harare_100k_bedrock_seed**: point features representing bedrock seeds, used for building polygons. These seeds contain the basic information as to geological unit and lithology.
- **Harare_100k_fault_or_fracture_trace**: line features representing faults
- **Harare_100k_bedrock_boundary**: line features representing (non-faulted) unit boundaries
- **Harare_100k_bedrock_polygons**: polygon features representing bedrock geology

The printed geological map of Harare contains numerous point-data, including the locations of mines and shafts, and various structural measurements such as the strikes and dips of bedding and foliation etc. It was beyond the scope of the current project to digitise these point data, although it would be possible to expand the GeoPackage with a digitised version of these data as part of future work.

2.2 LINE FEATURES

Lines were digitised by tracing the georeferenced paper map, following internal BGS specifications and quality assurance processes in order to meet standards of cartographic quality (Piper et al., 2025; Williams et al., 2025). These include the principles of scale, node density and placement, overlaps and joins, and seed placement, among others.

Digitised lines were assigned a 'feature' attribute that specifies what each line represents and what symbology style it displays as. The original paper map legend specifies four different line styles (symbology), see Table 1. Four additional styles of line symbology are present on the map-face of the original paper map, but did not have a legend entry; these are described in Table 2. The paper map-face contains labels referring to the names of several of the larger faults, dyke fractures and shear zones; these were not captured as part of the digitisation process.

Table 1. Line symbology styles used on the paper map, what they represent, and what they are translated as in the digital map.

Lines with a legend entry on the paper map		
Paper map		**Digital Map**
Symbology	**Description (legend)**	**Feature**
Bold dashed line	Fault	Fault_Undifferentiated_Inf
Solid line	Geological boundary	BedRock_Geology_boundary_Obs
Dashed line	Geological boundary, approximate or inferred	BedRock_Geology_boundary_Inf
Dotted line	Geological boundary, gradational or indefinite	BedRock_Geology_boundary_Grad

Table 2. Line symbology styles omitted from the paper map legend and deduced from the map-face.

Lines without legend entry on the paper map		
Paper map		**Digital Map**
Symbology	**Description (deduced)**	**Feature**
Bold solid line	Fault, observed	Fault_Obs_Downthrow_unspecified
No line, but a boundary is apparent due to pattern changes in the polygon symbology, e.g. between porphyritic and coarse-grained granite	Geological boundary	BedRock_Geology_boundary_Conj
The ends of laterally discontinuous units that are not marked by a line but by a colour change only	Geological boundary at the end of a laterally discontinuous unit	BedRock_polygon_closure

2.3 BEDROCK SEEDS AND THE LEX-RCS DATA MODEL

On the paper map, the bedrock geology is labelled and coloured based on lithology, with further details about the hierarchical rock unit classification (formation, member etc.) provided in the map legend.

The digitised version of the map captures this information in a “LEX-RCS” code data model, using a custom-created LEX-RCS dictionary. The LEX (**lex**icon) part of the LEX-RCS code contains the name of the rock unit as well as information about its position within the lithostratigraphical and lithodemic hierarchy (e.g., the Group, Formation, or Member, to which the unit belongs). The RCS (**R**ock **C**lassification **S**cheme) part of the code specifies the lithological composition of the unit.

As an example: MASH-D = Mashonaland Suite-dolerite.

During map digitisation, the LEX-RCS codes are initially attributed to a point feature dataset known as ‘bedrock seeds’, with one seed placed within the geographic extent of each polygon.

During the process of polygon building, the LEX-RCS attributes are subsequently transferred from the seeds to their respective polygons. The LEX-RCS dictionary and hierarchical structure that was created for the Harare map is designed to be consistent with the digital 1:1M scale national geological map of Zimbabwe and can be expanded during any future map digitisation work.

The LEX code hierarchy follows the broad principles of the BGS Lexicon (Graham et al., 2021). Here, it consists of 6 ranks, corresponding to the lithostratigraphic ranks of member, formation, subgroup, group, supergroup and a highest-level overarching ‘hypergroup’ (and their lithodemic equivalents). In the hierarchy, each unit belongs to a higher-ranking parent unit and can itself contain one or more lower-ranking child units (e.g., a formation is the parent unit of a member). Not all units have a complete set of hierarchical ranks (e.g., formations are not required to have members, and a group is not required to be subdivided into subgroups). Unit names were obtained from the paper map legend where these were available. For the naming of lithodemic units (e.g., supercomplex and suite) that are not named on the paper map legend, both the suggested practice of Maxeiner et al. (2024) and current best practice in BGS (not published) was followed. An overview of the LEX code hierarchy for the geological map of Harare is presented in Table 3.

The RCS broadly follows the terminology of Gillespie et al. (1999) and Robertson (1999); however, a new hierarchical system has been introduced, which is loosely based on McCormick & Heaven (2023). The RCS code hierarchy likewise consists of 6 ranks, where the highest rank specifies the general class of the rock (e.g., “igneous rock”; “metamorphic rock”; “vein rock” etc.) and each subsequent lower rank specifies the lithological makeup with increasing detail. Units that are represented by a single label on the paper map but comprise multiple lithologies according to the legend, are represented by RCS codes that begin with “X” (‘mixture’). A partial extract of the RCS code hierarchy is resented in Table 4 for illustrative purposes.

The attribute tables of the bedrock seed and bedrock polygon GIS layers contain the LEX-RCS code, as well as the LEX and RCS classification for every unit in a series of columns corresponding to the ranks to which a unit belongs (e.g., LEX_0, LEX_1, LEX_2, etc.). Table 5 shows two examples: a meta-andesite polygon belonging to the Murowodzi and Manyonga Members, and a pegmatite / quartz vein of unknown age and provenance.

The LEX-RCS data structure requires every polygon on the map-face to be assigned to a specific named unit and lithology. This aspect of the data structure caused a number of issues during the digitisation process, since several label-colour combinations that appear on the map-face of the paper map are non-unique, and occur multiple times in the map legend. For example, blue polygons with a ‘yl’-label occur a total of four times in the map legend (in the Iron Mask, Arcturus, Mt Hampden and Passaford formations) and the lithological descriptions for these legend entries contain slight differences (“Limestone”; “Limestone / marble”; and “Limestone (carbonated meta-arenite)”). These instances necessitated a degree of interpretation for some polygons in assigning LEX-RCS codes during map digitisation. In general, decisions in assigning LEX-RCS codes were made with the goal to keep the digital map as close to the paper version as possible, while not over-interpreting the paper geological map. Details for specific units are listed below in Section 3.

Table 3. Overview of the LEX code hierarchy of the Harare geological map

<table>
<tr><th>Rank 0
(Hyper- group eq.)</th><th>Rank 1
(Supergroup eq.)</th><th>Rank 2
(Group eq.)</th><th>Rank 3
(Sub-group eq.)</th><th>Rank 4
(Formation eq.)</th><th>Rank 5
(Member eq.)</th><th>LEX Code</th></tr>
<tr><td rowspan="15">Zimbabwe craton (Z)</td><td rowspan="6">Bulawayan Supergroup (BU)</td><td rowspan="6">Upper Bulawayan Group (UBU)</td><td></td><td>Iron Mask Formation (IMA)</td><td></td><td>IMA</td></tr>
<tr><td></td><td>Arcturus Formation (ARC)</td><td></td><td>ARC</td></tr>
<tr><td></td><td>Mt Hampden Formation (HAM)</td><td></td><td>HAM</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Passaford Formation (PAS)</td><td>Murowodzi / Mayonga Members (MUMA)</td><td>MUMA</td></tr>
<tr><td>Gwebi / Mapfeni Members (GWMA)</td><td>GWMA</td></tr>
<tr><td></td><td></td><td></td><td>UBU*</td></tr>
<tr><td>Zimbabwe Craton Granitic Supersuite (ZI)</td><td></td><td></td><td></td><td></td><td>ZI</td></tr>
<tr><td>Zimbabwe Gneiss Supercomplex (ZG)</td><td></td><td></td><td></td><td></td><td>ZG</td></tr>
<tr><td></td><td></td><td></td><td>Selby Intrusive Event (SBY)</td><td></td><td>SBY</td></tr>
<tr><td></td><td></td><td></td><td>Teviotdale Porphyry Swarm (TVD)</td><td></td><td>TVD</td></tr>
<tr><td></td><td></td><td></td><td>Umwindsi Shear Zone (USZ)</td><td></td><td>USZ</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td>Z†</td></tr>
<tr><td rowspan="3">Unknown (UN)</td><td>Mashonaland Suite (MSH)</td><td></td><td></td><td></td><td>MASH</td></tr>
<tr><td>Manyika Suite (MAN)</td><td></td><td></td><td></td><td>MAN</td></tr>
<tr><td></td><td></td><td></td><td></td><td>UN§</td></tr>
<tr><td>Water bodies (WTR)</td><td></td><td></td><td></td><td></td><td></td><td>WTR</td></tr>
</table>

Eq. = or equivalent
*Used for “Upper Bulawayan Group (undifferentiated)” units
†Used for various greenstone inclusions within the granitic terrain
§Used for various veins, dykes and intrusions of various (undefined) ages

Table 4. A partial extract of the RCS code hierarchy of the Harare geological map

Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6	RCS Code
Igneous rock	Felsic igneous rock	Granitic rock	Granite	Biotite-rich granite		GB
			Granodiorite	Granodiorite, coarse-grained		GDC
	Intermediate igneous rock		Andesite	Andesite porphyry		AP
			Diorite			DI
	Mafic igneous rock	Gabbroic rock	Dolerite	Olivine dolerite		DO
						D
			Gabbro	Differentiated gabbro		GBD
	Altered igneous rock	Granitic rock, altered	Granodioritic rock, altered	Hornblende granodiorite	Hornblende granodiorite, locally altered to hornblende granite	GDHA
Metamorphic rock	Meta-igneous rock	Mafic meta-igneous rock	Metabasalt			MB
			Metadolerite			MD
			Metagabbro			MGB
		Ultramafic meta-igneous rock	Serpentinite			MSER
	Meta-sedimentary rock	Meta-sedimentary rock -clastic	Metasandstone	Meta-arenite	Meta-arenite / sandstone	MARS
			Metasandstone	Metasandstone (undivided)		MSSTU*
			Quartzite	Grunerite quartzite		GMQ
		Meta-sedimentary rock - calcareous	Metalimestone ('limestone/marble')			MLST
		Meta-sedimentary rock - other	Metachert	Ferruginous metachert		MCH
		Combined meta-sedimentary rocks	Quartz-sericite schist / quartzite			XQSQ†

*Codes ending with "U" were commonly used for "Upper Bulawayan Group (undifferentiated)" units with a range of possible lithological compositions that is not further subdivided (see also section 3.1)
†Codes beginning with "X" were used for mixed lithologies

Table 5. Examples of LEX-RCS classification for 1) a meta-andesite polygon corresponding to the Murowodzi-Mayonga Members, and 2) an unnamed pegmatite & quartz vein polygon (n/a = not applicable). Each LEX and RCS rank is a child of the previous (parent) level/rank – i.e., Supergroup is a child of Hypergroup, Group is a child of Supergroup, etc. Some units do not have complete LEX or RCS attributes; for example, a Formation does not necessarily have a Member, and not all ranks are applicable in the rock classification scheme. RCS ranks 5 and 6 are not shown because they contain no values for these two examples.

LEX-RCS	LEX_0 Hypergroup	LEX_1 Supergroup	LEX_2 Group	LEX_3 Subgroup	LEX_4 Formation	LEX_5 Member	R_Rank 1	R_Rank 2	R_Rank 3	R_Rank 4
MUMA-MAN	Z - Zimbabwe craton	BU - Bulawayan Supergroup	UBU - Upper Bulawayan Group	n/a	PAS - Passaford Formation	MUMA - Murowodzi / Mayonga Members	M - Metamorphic rock	MI - Meta-igneous rock	MII - Intermediate meta-igneous rock	MAN - Meta-andesite
UN-XPGQ	Z - Zimbabwe craton	UN - Unknown	n/a	n/a	n/a	n/a	XVI – Combined vein and igneous rock	n/a	n/a	XPGQ – Pegmatite / vein quartz

2.4 ATTRIBUTE LIST

The full attribute tables of each layer contain specific feature details and metadata. Details for all attributes are recorded below in Table 6. In addition, the *Harare_100k_bedrock_polygons* layer has the full LEX-RCS dictionary codes (including all ranks, as described in Tables 3 and 4), along with supplementary definition ('*_D*') columns for each rank which contain the expanded definition of each code. The RGB and HEX values are matched with the colours on the paper map.

Table 6. Attribute list for each layer included in the Harare 100k digital map.

Attribute	Harare_100k_ bedrock_boundary	Harare_100k_ bedrock_seed	Harare_100k_fault_ or_fracture_trace	Harare_100k_bedrock_ polygons	Description
OBJECTID	Yes	Yes	Yes	Yes	the Object ID of the feature
FEATURE	Yes	Yes	Yes	Yes	the feature type (Fault, Geological Boundary etc.)
LABEL	Yes	Yes	Yes	Yes	an optional field for labels to be added to the map face
COMMENTS	Yes	Yes	Yes	Yes	an optional field for geological notes on the feature
USER_MADE	Yes	Yes	Yes	Yes	all values contain the value “BGS”
DATE_MADE	Yes	Yes	Yes	Yes	records the date the feature was created
UUID	Yes	Yes	Yes	Yes	a universally unique identifier for the feature
GUID	No	Yes	No	No	another UUID automatically assigned
LEX_RCS	Yes	Yes	Not applicable	Yes	the feature’s LEX-RCS code
HANG_WALL	Not applicable	Not applicable	Yes	Not applicable	an optional field in which the side of the hanging-wall of a fault can be recorded
THROW	Not applicable	Not applicable	Yes	Not applicable	an optional field in which the throw of a fault can be recorded
NAME	Not applicable	Not applicable	Yes	Not applicable	an optional field in which the name of the fault can be recorded
Harare100k_ MapCode	Not applicable	Not applicable	Not applicable	Yes	the map code used on the paper map
Harare100k_ LegendOrder	Not applicable	Not applicable	Not applicable	Yes	the order in which the unit appears on the paper map legend
Harare100k_ Description	Not applicable	Not applicable	Not applicable	Yes	the exact unit description as recorded on the paper map
Red	Not applicable	Not applicable	Not applicable	Yes	Equivalent red channel colour
Green	Not applicable	Not applicable	Not applicable	Yes	Equivalent green channel colour
Blue	Not applicable	Not applicable	Not applicable	Yes	Equivalent blue channel colour
HEX	Not applicable	Not applicable	Not applicable	Yes	Equivalent Hexadecimal value

3 Differences between the paper and digital map

3.1 GENERAL

The LEX-RCS dictionary was created by assigning LEX-RCS codes and the accompanying hierarchy to the legend entries on the paper map. The map digitisation process resulted in the identification of a number of polygons with colour/label combinations that either do not occur in the map legend or occur in the map legend as a child of a different parent unit than is portrayed on the map-face (e.g., several lenses of meta-andesite occur within the Mt Hampden Formation on the map-face, but no legend entry exists for meta-andesites within this formation). The LEX-RCS dictionary was consequently expanded to include definitions for these polygons without a legend entry. A complete overview of these additional LEX-RCS codes is provided in Appendix 1.

The paper map marks areas where rocks of the main greenstone belt formations are characterised by a metamorphic overprint (“amphibolitized//hornfelsed”), brecciation, porphyritic textures or pillow basalt morphology, by using patterned overlays within polygons (e.g., triangles or dots). The affected zones lack clear boundaries, however, and these variations within polygons could therefore not be digitised objectively. Instead, the entire polygon was assigned the LEX-RCS code of the parent formation and lithology (i.e., without breccia, porphyritic texture or pillow basalt morphology). The exceptions are the areas marked as amphibolitized/hornfelsed rock (present only in the Arcturus Formation), since in all observed cases the pattern overlays the entire polygon. For these occurrences the polygon as a whole was assigned a LEX-RCS code corresponding to the amphibolitized/hornfelsed RCS-subdivision (for example the basalt of the Arcturus Formation in the southeastern-most corner of the Harare Greenstone Belt; 31°27’50” E, 17°48’00” S). Similar patterned overlays representing rock textures (e.g., porphyritic textures) are used in the granite terrain. Because the regions characterised by these overlays had clear boundaries on the map, in contrast to those in the greenstone belt, they were digitised as separate polygons using the ‘conjectural geological boundary’ line style as polygon boundaries and the appropriate RCS-subdivisions.

Point features (structural data and the locations of mines and shafts) and labels for named faults, dyke fractures, and shear zones present on the paper map were not digitised.

3.2 THE HARARE GREENSTONE BELT

The Harare Greenstone Belt units are subdivided into formations, which are labelled and coloured by lithology and formation name on the paper map. They were assigned a LEX-RCS code using (1) the map legend and (2) the maps in the bulletin (Baldock, 1991) that show the generalised geographic extent of each unit. Each formation contains many lithologically distinct lenses & intrusions, which on the paper map are labelled and coloured by lithology only. The following general approach was used for assigning the LEX part of the LEX-RCS code for these lenses & intrusions:

- Polygons that are wholly contained within a single formation were assigned the LEX code of that formation
- Polygons that are located on the boundary between two formations, but clearly interfinger with one formation over the other, were assigned the LEX code of the main interfingering formation (e.g., ‘yi’-labelled bands between the Mt Hampden and Passaford formations in the northwest of the map sheet; 30°50’45” E, 17°39’45” S)
- Polygons that are located on the boundary between two formations and display no clear interfingering with either formation were assigned a generic “Upper Bulawayan Group (undifferentiated)” LEX code: *UBU* (see Table 3)

In all cases, an RCS code was assigned to reflect the lithological description present in the map legend. In some cases, this results in units with similar labels on the paper map having different

RCS codes. For example, the beige lenses labelled 'yqa' within the Mt Hampden Formation consist of "meta-arenite and sandstone" (RCS code: *MARS*), whereas lenses with the same colour and label in the Arcturus Formation consist of "meta-arenite / volcaniclastics" (RCS code: *XMARV*). For lenses of the "Upper Bulawayan Group (undifferentiated)", a specific 'undivided' RCS code was assigned to capture the lithological variability of polygons with that map code within the entire Upper Bulawayan Group parent unit – e.g. *XMS* for 'yqa'-labelled polygons.

3.2.1 Iron Mask Formation

On the paper map, the Inyauri macro-xenolith (in the Chinamora Igneous Complex in the northeast of the map, centred around 31°16'17" E 17°35'46" S) consists of 'yFa'-labelled polygons and a single small 'yB'-labelled polygon, which according to the map legend refer to respectively "Feldspathic amphibolite (meta-andesite); inclusions within the granite terrain" and "Metabasalt, Arcturus Formation". In the bulletin, however, Baldock (1991) describes these units as belonging to the Iron Mask Formation. The digitised map follows the classification of Baldock (1991), introducing the following new LEX-RCS codes that are not present on the legend of the paper map:

- *IMA-MAFD*: Iron Mask Formation; feldspathic amphibolite (meta-andesite) (4 polygons)
- *IMA-MB*: Iron Mask Formation; metabasalt (1 polygon)

3.2.2 Arcturus Formation

In the north-eastern corner of the map, between Mumurgwi and Frascati and just north of the Umwindsi Shear Zone, the paper map shows several polygons with symbology and labels that according to the legend are attributed to units in the Umwindsi Shear Zone (e.g., 31°26'25" E, 17°34'30" S). These polygons do not occur within the shear zone, however, and according to Baldock (1991) they belong to the Arcturus Formation. In the digitised map, these polygons are assigned to the Arcturus Formation following Baldock (1991), introducing the following new LEX-RCS codes:

- *ARC-MAPH*: Arcturus Formation; mafic amphibolite (3 polygons)
- *ARC-MDFS*: Arcturus Formation; felsic amphibolite (meta-andesite / dacite) (4 polygons)

3.2.3 Passaford Formation

The Passaford Formation is subdivided into two facies: the Passaford Facies in the northwestern part of the greenstone belt, and the Glen Lorne Facies in the southeastern part of the greenstone belt. Each facies is further subdivided into two members: the Gwebi Member and Murowodzi Member of the Passaford Facies; and the Mapfeni Member and Manyonga Member of the Glen Lorne Facies (Baldock, 1991). Because of their lithological similarities, the paper map does not distinguish between the Gwebi and Mapfeni members (both primarily meta-arenites & quartz schists) or the Murowodzi and Manyonga members (both primarily metadacites). In the digitised version of the map, both sets of members are combined into single LEX-RCS codes, following the paper map. As part of future work, it may be possible to further subdivide the LEX-RCS hierarchy for the Passaford Formation based on the information in the Harare map bulletin (Baldock, 1991).

3.2.3.1 Murowodzi and Manyonga Members

On the paper map, a SW-NE oriented elongate polygon extending from the Highlands neighbourhood to Glen Lorne northeast of Harare (31°8' E, 17°46'S), has the label and symbology of the Murowodzi and Manyonga members ('yqa', meta-arenite), but the same polygon is designated as part of the Gwebi and Mapfeni members in the map figure contained within the map sheet bulletin (Baldock, 1991). In the digitised version of the map, it was assigned the 'Murowodzi and Manyonga Members' LEX code, following the paper map.

3.2.4 Selby Intrusive Event

On the paper map, the metadolerite and metagabbro of the Selby Intrusive Event (Upper Bulawayan) is depicted using the same symbology (dark green) and map labels ('yDm' and ‘yHm’ respectively) as metadolerite and metagabbro units belonging to the Iron Mask, Arcturus and Mt Hampden formations. The map bulletin (Baldock, 1991) contains a generalised map showing the extent of the main Selby Intrusions, while the accompanying text notes that the abundant smaller intrusions are more difficult to assign to either the Selby Intrusive Event (*SBY)* or one of the formations, due to the sparsity of unambiguous field, petrographic and/or geochemical evidence.

During map digitisation, polygons were assigned to the Selby Intrusive Event following the map in the bulletin (Baldock, 1991). Any metadolerite and metagabbro polygons within the greenstone belt that were not identified as part of the Selby Intrusive Event in the bulletin, were assigned to ‘Upper Bulawayan Group (undifferentiated)’. Several polygons representing lenses within the greenstone belt that are entirely surrounded by polygons of the Selby Intrusions, and therefore lacked any unambiguous parent formation (e.g., ‘yi’ and ‘yl’-labelled polygons, respectively meta-ironstone and meta-limestone), were also assigned to ‘Upper Bulawayan Group (undifferentiated)’.

The map figure in the bulletin assigns some occurrences of serpentinite on the paper map (labelled ‘yS’) to ultramafic intrusions of the Selby Intrusive Event. Additionally, some occurrences of actinolite lenses (labelled ‘yt’) are clearly part of intrusion bodies identified as belonging to the Selby Intrusive Event in the bulletin map figures (Baldock, 1991). The paper map legend does not include these lithologies in the Selby Intrusive Event, but these polygons were assigned to the Selby Intrusive Event in the digitised version of the map, following the bulletin.

Metadolerite and metagabbro intrusions in the granitic terrain are also difficult to classify. A mafic and an ultramafic intrusion occurring in the granitic terrain in the northeast of the map sheet may be part of the Selby Intrusive Event due to lithological similarities and are included in the bulletin map figure of the Selby Intrusive Event for this reason (Baldock, 1991). Because their relation is not proven, however, Baldock (1991) refers to the ‘inclusions in the granitic terrain’ section for a detailed description. On the digitised version of the map, the ultramafic polygon (serpentinite) is assigned to ‘inclusions in the granitic terrain’ (31°27’10”E, 17°34’20” S), whereas the mafic polygon (metadolerite) (31°24’E, 17°35’20” S) is assigned to ‘various ages’, both following the paper map legend rather than the bulletin map figure.

3.3 ‘GREENSTONE’ INCLUSIONS IN THE GRANITIC TERRAIN

The granitic terrain contains numerous inclusions comprising lithologies that are similar to those in the Harare Greenstone Belt; in the bulletin these are referred to as: *‘Greenstone’ inclusions in the granitic terrain and along the Umwindsi Shear Zone* (Baldock, 1991). On the paper map legend some of these lithologies are classified as belonging to either the ‘Umwindsi Shear Zone’ or ‘Inclusions in Migmatites’. On the map-face, however, these lithologies do not always exclusively occur within the shear zone or migmatites, respectively. Vice versa, some lithologies that are not classified as the ‘Umwindsi Shear Zone’, do occur within the shear zone. On the digitised map, any lithology occurring along or directly adjacent to the Umwindsi Shear Zone was assigned an ‘Umwindsi Shear Zone’ LEX code, whereas all other inclusions were assigned a generic ‘Zimbabwe Craton’ LEX code (regardless of whether they are hosted within migmatites or not; see Table 3).

3.4 THE GRANITIC TERRAIN

A map figure in the Harare map bulletin shows that the granite terrain is subdivided into four igneous complexes: the Chinamora Igneous Complex, the Nyabira Complex, the Harare Complex and the Chikwakwa Injection Complex, as well as restricted areas of ‘Basement’ Gneiss (Baldock, 1991). These subdivisions are not reproduced on the paper geological map, where the granitic terrain is instead subdivided on the basis of lithology alone. The digitised version of the map follows the paper map and does not subdivide the granitic terrain into the various igneous complexes. Instead, the granitic terrain polygons are subdivided into two LEX-codes: a ‘Zimbabwe Craton Granitic Supersuite’ group comprising granite/granodiorite lithologies and a ‘Zimbabwe Gneiss Supercomplex’ comprising gneiss/migmatite lithologies, following a subdivision that was recognised during the compilation of the national 1:1M scale geological map of Zimbabwe. As part of future work, it would be possible to further subdivide the LEX-RCS hierarchy for the granitic terrain based on the information in the Harare map bulletin (Baldock, 1991).

A small polygon in the southeast of the map sheet (northwest of Goromonzi, 31°21'20"E, 17°50'50" S), is labelled 'G' (granite) on the paper map but is coloured with a contradicting symbology (pink with dots, referring to coarse-grained granite with map label 'Gc'). In the digitised version of the map, this polygon was assigned a LEX-RCS code corresponding to 'coarse-grained granite', based on the nearby presence of similar polygons that have the symbology and label corresponding to 'coarse-grained granite'.

3.5 UNITS OF VARIOUS AGES

3.5.1 Manyika Suite

The legend on the paper map has two entries belonging to the Manyika Suite, namely "Differentiated gabbro" and the "Harare Gabbro". The map sheet bulletin is less definitive in its interpretation, stating the Harare Gabbro *may* be part of the Manyika Suite due to lithological similarities. In the digitised version of the map, all these polygons are assigned to the Manyika Suite, following the legend on the paper map.

One polygon in the northeast of the map sheet, between Ruwanga and Rusikana (31°25'E, 17°31'S), is labelled as Harare Gabbro (map label 'H'; LEX-RCS code: MAN-GBH) on the paper map. According to the bulletin, however, the Harare Gabbro (sensu stricto) occurs exclusively in the city region of Harare. This polygon is therefore taken to have been labelled erroneously on the paper map and was digitised as part of the 'differentiated gabbro, Manyika Suite' (map label 'Hx'; LEX-RCS code: MAN-GBD).

Appendix 1

The following LEX-RCS codes were introduced for polygons that had no legend entry:

Parent	Lithology	Unit code	Number of polygons
Upper Bulawayan Group (undifferentiated)	meta-ironstone ('iron-formation')	UBU-MIR	33
Upper Bulawayan Group (undifferentiated)	metalimestone ('limestone/ marble')	UBU-MLST	8
Upper Bulawayan Group (undifferentiated)	meta-andesite	UBU-MAN	1
Upper Bulawayan Group (undifferentiated)	serpentinite	UBU-MSER	4
Upper Bulawayan Group (undifferentiated)	metarhyolite	UBU-MRY	3
Upper Bulawayan Group (undifferentiated)	metasandstone (undivided)	UBU-MSSTU	2
Upper Bulawayan Group (undifferentiated)	metachert (undivided)	UBU-MCHU	2
Upper Bulawayan Group (undifferentiated)	phyllite (undivided)	UBU-PMSU	16
Upper Bulawayan Group (undifferentiated)	combined metasedimentary rocks	UBU-XMS	3
Upper Bulawayan Group (undifferentiated)	metadolerite	UBU-MD	67
Upper Bulawayan Group (undifferentiated)	metagabbro	UBU-MGB	14
Iron Mask Formation	actinolite (talc) schist (meta-ultramafic)	IMA-MACT	1
Iron Mask Formation	feldspathic amphibolite (meta-andesite)	IMA-MAFD	4
Iron Mask Formation	metabasalt	IMA-MB	1
Arcturus Formation	metarhyolite	ARC-MRY	5
Arcturus Formation	ferruginous metachert / meta-ironstone ('iron-formation')	ARC-XMCI	1
Arcturus Formation	mafic amphibolite	ARC-MAPH	3
Arcturus Formation	felsic amphibolite (meta-andesite/meta-dacite)	ARC-MDFS	4
Mt Hampden Formation	meta-andesite	HAM-MAN	7
Gwebi/ Mapfeni Members	actinolite (talc) schist (meta-ultramafic)	GWMA-MACT	1

Gwebi/ Mapfeni Members	meta-andesite	GWMA-MAN	2
Murowodzi/ Manyonga Members	actinolite (talc) schist (meta-ultramafic)	MUMA-MACT	2
Selby Intrusive Event	actinolite (talc) schist (meta-ultramafic)	SBY-MACT	2
Selby Intrusive Event	serpentinite	SBY-MSER	2
Umwindsi Shear Zone	grunerite quartzite	USZ-GMQ	5
Umwindsi Shear Zone	iron-formation	USZ-MIR	9
Umwindsi Shear Zone	serpentinite	USZ-MSER	5
Umwindsi Shear Zone	metabasalt	USZ-MB	3
Umwindsi Shear Zone	metadolerite	USZ-MD	1
Zimbabwe Craton	actinolite (talc) schist	Z-MACT	3
Zimbabwe Craton Granitic Supersuite	hornblende granodiorite, porphyritic	ZI-GDHP	1
Zimbabwe Craton Granitic Supersuite	hornblende granodiorite, locally altered to hornblende granite	ZI-GDHA	1
Unknown	quartz and pegmatite	UN-XQPG	3
Unknown	pegmatite and quartz	UN-XPGQ	1
Water bodies (lakes & reservoirs)	unknown	WTR-UNKNOWN	24

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The British Geological Survey holds most of the references listed and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at https://ukrinerc.on.worldcat.org/discovery

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