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- Qualitative assessment to the geological heritage of Tundavala (Angola) has been done
- Data regard both the degree of relevance and the public perception of the site
- Results show that Tundavala display documental, symbolic and scenic contents
- Heritage contents of Tundavala can support geotourism implementation in the region
- Assessment methodologies used in Tundavala can be applied to other African regions

The Geological Heritage of Tundavala (Angola): an integrated approach to its characterisation

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Abstract

This paper presents the results obtained using a qualitative assessment approach to characterise the geological heritage of Tundavala (Huila, Angola), needed in order to support a future classification proposal for the territory to ensure its preservation, as well as to promote geotourism, thus contributing towards sustainable local development.

In order to characterise the geological heritage of Tundavala a set of various types of data for the different contents displaying heritage value was collected and processed. It was analysed in an integrated manner, taking into consideration data on the meanings attributed to Tundavala by scientific communities (degree of relevance), and public perceptions of such meanings (abstract perceptiveness).

The results allow us to recognise in Tundavala, an object displaying heritage value, more than one type of content - documental, symbolic and scenic - which provides it with a degree of

regional relevance and enhances its value as an element that incorporates the geological heritage of the earth.

The methodologies used to characterise the geological heritage of Tundavala are independent of any national, regional and/or local legislation on geoconservation, whether they exist or not, and thus represents a useful tool for evaluating geological heritage in any place on earth, particularly in countries and/or regions where local geological knowledge is sparse and/or there is little public awareness of geoconservation.

Keywords: Tundavala, Angola, Geological Heritage, Geotourism, Sustainable Development.

1. Introduction

Geodiversity, considered as geological assemblages, their relationship, properties interpretations and systems (Gray, 2004), is an important natural factor underpinning biological, cultural and landscape diversity, as well as an important parameter that should be considered in the assessment and management of natural areas (IUCN, 2008). Like biodiversity conservation, geodiversity conservation is a social concern. As argued by the IUCN (2012a), biodiversity benefits from geodiversity conservation and thus from the resilience created by proper geoconservation.

Geoconservation requires inventory and evaluation procedures which play a decisive role in the implementation of any subsequent conservation, by evaluating and monitoring the geological heritage (Henriques et al., 2011). Geoconservation strategies must strengthen the complexity of the field, with regard to both scale and scientific requirements (Erikstad, 2013), and the ethical values of geoconservation have to be perceived not only as environmental resources but also as part of the global cultural heritage (Bruno and Perrotta, 2012).

As pointed by Pena dos Reis and Henriques (2009), geological objects refer to a wide range of geological features from microscopic (e.g., minerals) to gigantic (e.g., mountain belts) dimensions. The evaluation of geological objects displaying heritage value, which include both natural geological sites and the heritage associated with geological sites (e.g., the fossil collections stored in museums; Schemm-Gregory and Henriques, 2013), should not be limited to statements by scientific communities regarding their geological properties without also considering the attributes socially assigned to them (Pena dos Reis and Henriques, 2009; Bruno and Perrotta, 2012).

This view is also emphasised by Eriskstad (2013), who considers the local sense of place and local geoheritage perspectives as the key to management initiatives directed towards implementing sustainable development measures (Segnestam, 2002), namely through geotourism, which represents an opportunity for many countries and regions to promote an identity that is unique to a particular place (Dowling, 2011).

Geotourism is a form of natural tourism that focuses specifically on geology and landscape, representing a process for promoting tourism based on geosites which fosters geoheritage conservation through appropriate sustainability measures, advances sound geological understanding through interpretation and education, and generates tourist or visitor satisfaction (Dowling, 2011), as well potential economic benefits (Simpson, 2008; Hose and Vasiljevic', 2012). Moreover, it is a comprehensive means of transferring and exchanging information (Fuertes-Gutiérrez and Fernández-Martínez, 2012) as a basic requirement to support environmental management, maximise opportunities and minimise adverse impacts through environmentally sustainable development and planning (Dowling, 2010).

Reimold (1999) has highlighted the importance of the protection of natural sites in Africa as a bonus for ecotourism and geotourism. Although some authors have debated the efficiency of legislation and rules for the conservation of the geological heritage, especially in South Africa (Cairncross, 2011; Ruban, 2012), some important works emphasise the relevance of exploring

African geodiversity as the key to scientific development and support cultural initiatives for sustainable development (Reimold, 1999; De Wit and Anderson, 2003; Alfama et al., 2008; Johnson et al., 2010; Dawson, 2010; Fauvelle-Aymar et al., 2010; Tavares et al., 2012; Henriques et al., 2012, among others). These approaches are supported by most African countries, which have recognised the importance of preserving natural resources, and 45 of them already subscribe to the World Heritage Convention, thereby agreeing to identify and nominate properties within their national territory to be considered for inclusion in the World Heritage List as cultural, natural or mixed properties (Schlütter, 2006; UNESCO, 2010).

In 1991 Angola ratified the Convention (UNESCO, 2010) but as yet none of the 962 properties (745 cultural, 188 natural and 29 mixed properties) that form part of the cultural and natural heritage included in the World Heritage List are located in its territory (UNESCO, 2012). However**,** as a State Party to the World Heritage Convention, Angola has a responsibility to "ensure the identification, nomination, protection, conservation, presentation, and transmission to future generations of the cultural and natural heritage found within its territory", "integrate heritage protection into comprehensive planning programmes", "take appropriate legal, scientific, technical, administrative and financial measures to protect the heritage" and "submit to the World Heritage Committee an inventory of properties suitable for inscription on the World Heritage List" (pp. 3-4).

As in many other regions all over the world, the nature conservation policies implemented in Angola have led to the approval of legal instruments that have created misconceptions of nature, confusing it with its biological component only (Henriques, 2004). As stated in the National Biodiversity Strategy and Action Plan of Angola (2007-2012), "the legal framework in the country is composed of a series of environmental laws for different sectors, namely land, fisheries, water resources, petroleum and mines, as well as laws on the protection of biological diversity and management and pollution control" (NBSAP, 2006 , p. 9). Protected Areas in Angola include 6 National Parks, 1 Regional Natural Park, 2 Integral Natural Reserves and 4

Partial Natural Reserves, corresponding to 82,000 Km^2 , or 6.6% of the country (SCEAP, 2012), mainly directed towards the conservation of biodiversity and the biological heritage.

In this paper the geological heritage of an emblematic site in Angola (the Tundavala Gorge) is described in terms of its geological content and social recognition, in order to support future geoconservation actions to foster sustainable development and planning. The paper will address the following: (1) a geological characterisation of the Tundavala site; (2) its geoheritage contents and values; and (3) geoconservation strategies and action proposals. The results may serve to support ongoing perspectives for the growing tourism in Huíla Province (SDCI, 2004). In addition, they represent a contribution to the production of a global inventory of important African geological sites for classification and prioritisation purposes (Schlütter, 2006), as well as the need to pursue a unified African geoconservation strategy (Reimold, 1999) such as the "Gondwana Alive Corridors" project (De Wit and Anderson, 2003) which preceded the ongoing "Africa Alive Corridors" project (Toteu et al., 2010).

2. The Tundavala site: location and geological framework

The Tundavala Gorge, which "offers stunning views of the Huila plateau and Namibe" (SDCI, 2004, p. 39), is often described as a place to visit in the south of Angola, because of its tourism potential, reflecting a strong "imageability" in the observer (Ode et al., 2008). The Tundavala belvedere overlooking the incise gorge (Fig. 1) provides a clear north-western view of over 10,000 square kilometres towards Namibe, situated about 130km away on the coast (Fig. 2). The site is mentioned in the National Biodiversity Strategy and Action Plan (2007-2012) (NBSAP, 2006) as one of the areas in Angola that should be protected, especially taking its landscape values into account, given that it is considered one of the wonders of Angola (Percival, 2009).

The Tundavala site is located on the edge of the Humpata Plateau (13º 22' S; 14º 49' E) about 20 km from Lubango, the capital of Huíla Province (Southwest Angola; Fig. 3). This table forms a structure corresponding to the Serra da Chela, ending in the west in imposing cliffs standing about 1,000 m high (e.g., Bimbe and Leba in the south) that define the boundaries of a volcanic-sedimentary intracratonic basin from the Paleo-Meso-Proterozoic era, mainly deposited within an interval of 1947-1810 Ma (Pereira et al., 2011) and analogous to others located in the Congo Craton (Pereira and De Waele, 2008). The inner part of this so-called Angolan Block of the Congo Craton (e.g., Carvalho et al., 2000; Delor et al., 2008) has remained stable since the Limpopo -Liberian (c. 2680 Ma to c. 2820 Ma) and Eburneano and/or Tadilian (c. 2100 Ma to c. 2000 Ma) orogenic cycles, unlike the peripheral zones, which have been reactivated during the Maiombian (1300±200 Ma), Kibarin (1300±100 Ma) and Pan-African orogenic cycles (c. 975 Ma to c. 550 Ma) (e.g., Carvalho, 1983; Carvalho and Alves, 1993; Ferreira da Silva, 2009; Lopes et al., 2012).

The edge of the Humpata Plateau has very rugged facets alternating between NW-SE and NE-SW orientations. They form small polygons in the west and south-west, whereas towards the north-east their appearance is dendriform (Lopes et al., 2012). These features are represented by fractures and deep canyons opening westwards, of which the Tundavala Gorge, standing more than 2,200m high, is a particularly good example (Fig. 4). The resulting impressive landscape is a natural resource that incorporates the geological elements of 'form and process' which, if combined with elements of tourism such as attractions, accommodation, tours, activities, interpretation and planning and management, can boost geotourism, a sustainable form of tourism that focuses primarily on experiencing the earth's geological features in a way that fosters environmental and cultural understanding, appreciation and conservation, and is beneficial to the local area (Dowling and Newsome, 2006; 2010).

3. Methodology

Several methodological approaches to geological heritage appraisal have already been proposed (e.g., Alexandrowicz, 1998; Wimbledon et al., 1995; Panizza, 2001; Reynard, 2005; Coratza and Regolini-Bissig, 2009; Mansur and Carvalho, 2011; Fuertes-Gutiérrez and Fernández-Martínez, 2012), focussing on criteria related to different values such as intrinsic, cultural and aesthetic, economic, research, educational, and functional values (Gray, 2004). Other theory-based models supported by visual indicators representing the quantifiable characteristics of landscapes (Ode et al., 2008) or emphasising landscape values (Palmer and Hoffman, 2001; Germino et al., 2001) have also been developed.

In this work an integrated approach has been used to characterise the geological heritage, based on qualitative criteria for content, which may support future evaluations of the geological heritage of Angola and/or the Huíla Province aiming at its geoconservation. This holistic perspective, drawing on knowledge from the different sciences and avoiding the current "tendencies towards reductionism and apartheid between the natural and social sciences" (Toteu et al., 2010, p. 712), may prevent a biased protection of the geological heritage of the earth that overemphasises the geological properties of geological objects instead of attributes related to their social appropriation. Moreover, an open system of this kind can be used regardless of the existence or lack of national, regional and/or local legislation and/or geoconservation organisations, and it can supplement the existing nature conservation status of areas already legally protected for reasons other than geological ones.

In order to characterise the geological heritage of Tundavala a set of various kinds of data for the different contents with heritage value was collected and processed using the conceptual model developed by Pena dos Reis and Henriques (2009; Fig. 5). Their methodological approach refers to the meanings attributed to geological objects by the scientific communities (the relevance grade) and public perceptions of such meanings (abstract perceptiveness), a factor that reflects the range of social benefits of the area.

A set of data was collected to characterise the geological heritage of Tundavala with the aim of analysing (1) the geological and landscape characterisation of the site, and (2) the social perceptions of local communities regarding the environment and heritage, which reflect local actors´ concerns about planning and implementing geotourism activities in the site, using the methodology represented in Fig. 6. The fieldwork involved physical identification of the region and public surveys; the desk work involved content analysis of several documents from very different sources.

Several analytical instruments were specially designed for this purpose, as described in Bala (2011) including a survey of the local population using a questionnaire that focused on their relation to the Tundavala Gorge (Instrument 1), a content analysis of different scientific documents referring to Tundavala, represented by books, papers, and monographs (Instrument 2), and a content analysis of non-academic literature and web pages concerning the environmental and touristic attributes of the site (Instrument 3).

The first instrument was directly administrated to a sample of 30 inhabitants in the Tundavala region, aged over 18, and consisted of two groups of questions, one asking about frequency and reasons for visiting the site, and the other categorising intangible cultural elements that refer to Tundavala (namely oral traditions and expressions, such as folk tales, fables, proverbs, rhymes, songs, prayers, and chants).

The second instrument was designed to analyse the content of both scientific and non-academic written documents (12 published books, articles and monographic collections and 22 documents on environmental and tourism themes) based on Berelson (1971), later supported by the GAO (1996) and Krippendorff (2004) methods, focusing on the conceptual and relational elements present in the documents. Document size and the relevance of the topic of Tundavala within the text were analysed. In order to evaluate textual content, keywords and the scientific domains (ethnographic/anthropological, historical, environmental and biogeophysical) under which the documents could be classified were also categorised. The

graphic content was analysed by identifying the number of elements (photographs and diagrams) they contained and the iconographic representations relating to the landscape and scientific domain (biotic, geologic, geomorphologic, social and other) under which the documents could be classified.

The third instrument was designed to analyse the content of web pages referring to Tundavala (80 in total), including textual and graphic representations, and using analysis grids. It was supplemented by an analysis of the website structure and provenience, as well as the website proposal (Haas and Grams, 2000), specifically relating to personal and/or group memories and experiences.

4. The Tundavala site: heritage contents

Data on the degree of relevance was analysed in an integrated manner in combination with data on abstract perceptiveness. Taken together, the results allow us to identify in Tundavala, an object displaying heritage value, several types of content - documental, symbolic and scenic – as described below.

4.1. Documental

Documental content "corresponds to a highly demonstrative record particularly relevant for the understanding of significant geological changes assigned to a region" (Pena dos Reis and Henriques, 2009, p. 6), and data supporting such values is mainly produced by scientific communities. According to the academic literature analysed (Instrument 2), the Tundavala outcrop represents a unique record of remote episodes in the earth's history dating from the Archean Eon, materialising in the stratigraphic record for the Chela Group, the litostratigraphic sequence located further west of the Congo Craton, where several other analogous Paleo-

Meso-Proterozoic basins have been identified. These African Basins are contemporary with others in the São Francisco Craton (South America), represented by granite-greenstone belt sequences and high-grade terrains dating from between approximately 2080 and 3400 Ma (Carvalho et al., 2000; Oliveira et al., 2006). They both represent stable blocks from a continental mass from the Archean Eon that was initially coherent (the Columbia super-continent) but, after being subjected to several events along the margins (in the Meso-Proterozoic era, associated with the formation of the super-continent Rodinia, and in the Neo-Proterozoic era, associated with the aggregation of Gondwana), fragmented during the opening of the Atlantic (Pereira and De Waele, 2008).

The initial cohesion of the San Francisco and Congo Cratons prior to the existence of Gondwana is supported by the occurrence of similar epicontinental Pre-Cambrian sequences on both sides of the Atlantic Ocean, including those representing the Espinhaço Super-Group in Brazil (which includes the Chapada Diamantina Group outcropping in the Chapada Diamantina National Park; Pedreira and Bonfim, 2002), and the Chela Group in Angola (Pereira and De Waele, 2008).

The Chela Group comprises five formations - Tundavala (consisting of conglomerates at the base and overlapping sandstones with interbedded pyroclastic), Humpata (vulcanoclastic rocks, resulting from explosive volcanism, with interbedded sandstones), Bruco (volcanogenic conglomerates at the base, overlapping sandstones and siltstones interbedded with volcanic and conglomeratic levels), Cangalongue (alternating argillites, limestones and arcosarenites) and Leba (chertes, argillites and stromatolitic dolomites) (Pereira and De Waele, 2008; Pereira et al., 2011; Fig. 7).

As Tundavala displays, in a particularly representative way, the stratigraphic record for the Chela Group, being the type locality for one of its formations (the Tundavala Formation), it is possible to assign it a documental content with regional relevance (Pena dos Reis and Henriques, 2009; Henriques et al., 2012).

255

256 **4.2. Scenic content**

257

258 The scenic content "corresponds to regional scale content, providing high recreational
259 function", in which "landscape value, a highly abstract concept, is determinant in this category,
260 so its public understanding and use attains a maximum"(Pena dos Reis and Henriques, 2009, p.
261 7). The data for this value was obtained using Instruments 2 and 3. Instrument 2 corresponds
262 to a content analysis of 22 documents on environmental and tourism themes, from both
263 private (14) and public (8) bodies such as tourism enterprises and the municipal tourism office.
264 Eight of them are national publications, nine are regional and the remainder are local. Figure 8
265 shows the relevance of Tundavala in the documents analysed, in which short descriptions
266 prevail, referring to it as part of a sightseeing tour, or simply naming the site. Only a couple of
267 documents present the Tundavala Gorge as a central issue and both contain less than 500
268 words in total.
269 The frequency of keywords in text titles included in publications on environmental and tourism
270 themes highlight four terms: Tourism – 5; Park – 5; Richness – 4; Economy-4. The frequency of
271 keywords in the content of texts included in publications on environmental and tourism
272 themes show that *imposing* (view), *tourist attraction, gorge* and *Lubango* (the nearest town)
273 are the most frequent words (Table 1).
274 In order to analyse the graphic content included in the documents, the number of elements
275 (photographs and diagrams) and the relationship between these representations and the
276 different scientific domains (biotic, geologic, geomorphologic, social and other) were
277 determined. The results highlight the high frequency of images (40) of Tundavala as the only
278 type of representation. The gorge is the most common element, followed by the image of the
279 western landscape obtained from the Tundavala belvedere (Fig. 9).

The 80 website pages analysed, based on a search for the reference "Tundavala" between the 13th and the 27th September 2011 with no restrictions on language, format or domain, come from public organisations (1), private organisations (25), the media (17) and personal sources (25). 19 are organised into a single-tier hierarchy, 51 display a multitier hierarchical architecture, and 10 a web-like site structure. The page content can be classified as scientific (9), related to leisure activities, i.e. tourism and sports (63), and reporting (personal and group) memories (8). An analysis of the frequency of keywords within the textual content included in the web pages indicates the scenic attributes assigned to Tundavala (Table 2).

The graphic content of the web pages is dominated by photos (45), although film (28), animation (8) and diagrams (1) are also present. Again, the most frequently represented feature is the landscape scenario and the gorge (Fig. 10). Concerning the captions and titles of the graphic contents, the single word "Tundavala" is the most common (37), although "Huíla video" is also mentioned, recalling the fact that Tundavala belongs to the Huíla Province. These results allow us to assign scenic content to Tundavala, supported by different sources. Despite this, the scenic content of Tundavala is limited to the landscape and the gorge, strongly characterised by a wide range of subjective attributes emerging from the public's perceptions of its aesthetic value, amongst whom the tourism potential is also recognised.

4.3. Symbolic content

The symbolic content "refers to local scale content in a highly socialized place largely used by the public due to reasons other than geological ones" (Pena dos Reis and Henriques, 2009, p. 6). Each of the peoples inhabiting the region culturally interprets the Tundavala landscape differently, thus assigning a wide range of symbolic elements to the site. The word Tundavala comes from the local people's perception of the natural features of the region, expressed in the Nyhaneka language. The expression Tundavala is derived from a corruption of the

306 Portuguese pronunciation of the original Nyhaneka term "Ntandavala", which has the
307 following meanings: “what was attached/shrunken and stretched”, “what is open/apart”, “the
308 aperture”, or even “the space left by two sides” (Bala, 2011).
309 In addition to these interpretations, other representations attributed by local communities are
310 associated with Tundavala. For the Ovahumbe (the indigenous people of Quilengues) residing
311 in the N-NE of the region, Tundavala is a place associated with fertility - translated in the
312 expression: “kukambetaili okamono lucito kalumoneka olukavamjawa kokatala kombeki
313 alucapupulwa kocela” (“Do not hit my child, because to become fertile we have to go into the
314 opening of the sacred mountain of Chela and then go to the Katala hospital” - or to the
315 impossibility of being able to move beyond the precipice – as represented by the expression
316 “Onculo yo uye konjenjelela” (“The place where the end of the world lies”) (Bala, 2011;
317 Henriques et al., 2012).
318 In order to determine how the people inhabiting the region culturally interpret the Tundavala
319 landscape, a questionnaire (Instrument 1) was administered to 30 national individuals (local
320 and non-local). It included four multiple-choice questions and a question on the kind of work
321 they do: whether they like to visit Tundavala, how often and why they visit Tundavala, and
322 whether they know about the ethnographic records relating to Tundavala. The results show
323 that most of the respondents regularly visit Tundavala (once a month or once a year). With
324 regard to intangible cultural elements, 18 respondents referred to oral traditions and
325 expressions, such as folk tales (3), fables (4), proverbs (3), rhymes (3), songs and chants (3),
326 and prayers (2) related to Tundavala.
327 The inhabitants interpret the shape of Tundavala (the gorge and cliff) as the vengeance of a
328 god who could not dominate the world. They refer to “Ompunda Yokwatandavala” as a
329 traditional song dedicated to female fertility, and “Lipundica ny kuyakule. Thandavala ny
330 kueleke” as a proverb, which means “going out to the cliff without foreshadowing, counting
331 only on luck”. They also associate the site with water in traditional songs and proverbs, based

on the local expression “Ko Ntandavala mepunnyu lyo mepunda elundu manya lipola ohunga ovaluvango, litalaleka nomeva omapya onanankono”, meaning “The Tundavala is the water coming from the stones of the mountain, which quenches the thirst of the people and irrigates the crops”. When asked about the landscape, the respondents considered the site “an impressive place”, “a wonder of nature”, and expressed concerns about its preservation, considering that “it deserves to be preserved and maintained as it is now”. Some negative associations with Tundavala were expressed by three respondents who associated the site with the recent civil war in Angola (1975-2002), stating that “Unfortunately, it is known in Lubango that the Tundavala slit was used to physically eliminate people, without any chance of trial”, or that “I heard that once people were killed in Tundavala. People were thrown down there because they did not obey the military regime”.

The data collected shows that the cultural elements are generally organised into four types, referring to the symbolic elements, highlighting the scenic elements, relating to conflict and focusing on water as a resource/source of life.

Regarding the social perception of Tundavala resulting from the content analysis of the web pages (Instrument 3), the data shows the relevance of the issue of its economic value, as well as individual and collective memories. The data supports the tourism potential of the site, although relations with the resulting benefits are not clear (Table 2). Memories can be divided into two types: one relating to the former military regime from colonial times, and the other to individual or group leisure activities such as trekking and photography. Sports and hunting were not mentioned.

The results obtained support the identification of the local, symbolic heritage content of the Tundavala site, a heritage content assigned to a highly socialised place frequented for reasons other than those resulting from its geological significance (Pena dos Reis and Henriques, 2009).

5. The Tundavala site: heritage value

Geological objects can display more than one heritage content, thus increasing both their value and conservation priority (Pena dos Reis and Henriques, 2009). Taken together, the results obtained enable us to recognise in Tundavala, an object displaying heritage value, more than one type of content - documental, symbolic and scenic - which gives it a degree of regional relevance and enhances its value as an element that incorporates the geological heritage of the earth (Fig. 11).

The documental content results from the significance of the stratigraphic record of the Chela Group, in particular the Tundavala Formation, formally defined therein as a litostratigraphic unit. The scenic and symbolic content emerges from social perceptions of Tundavala. The results show that, for its inhabitants, the Tundavala site encompasses symbolic representations that are strongly embedded in their culture, associated with stories, songs, proverbs, and more recent memories of conflicts. For visitors from further afield, Tundavala takes on other meanings related to tourism, and its status as an imposing cliff - widely represented in photographs in the publications analysed - the central element of both interpretations. The terms "tourism", "tourist", "landscape" and "monument" appear significantly in web pages and are referred to in guides, mostly published by private organisations, in which photographs of the Tundavala cliff are very common.

The resulting qualitative characterisation of the geological heritage of Tundavala justifies the need to design and implement measures to ensure its geoconservation, including public policy measures - requiring the creation and implementation of legal instruments for the protection and valuing of the geological heritage - and specific measures to encourage the active involvement of citizens, either individually or collectively, in different actions, whether public or private, that may enhance geotourism and promote sustainable development (Henriques et al., 2012).

6. Conclusions and implications

Nature includes both biotic and abiotic components, which together form natural diversity on all geographical levels, from local to landscape, regional and continental scales (IUCN, 2012b). As established by the World Heritage Convention (UNESCO, 1972, article 2), “natural features consisting of physical and biological formations or groups of such formations which are of outstanding universal value from an aesthetic or scientific point of view”, as well as “natural sites or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty” should be considered "natural heritage", and therefore need to be preserved as part of the world heritage of mankind.

The Tundavala site, as demonstrated above, meets the criteria established by the Convention for “natural heritage”, and its geoconservation should be considered a priority by Angola as a State Party to the World Heritage Convention. However, in contrast to Europe, where geoconservation is actively pursued, in Africa although many countries contain countless important geological sites, geoconservation has a very poor record (Reimold, 1999; Schlütter, 2006).

In fact, geodiversity conservation still remains far removed from political concerns and public awareness in Angola, in spite of its crucial role in ensuring that the current geoheritage is passed on to future generations as a potential research opportunity for advancing science and industry, a training ground for earth scientists, a formal and informal educational facility and a tourism resource (Hose, 2012; Martínez-Frías and Mogessie, 2012). As previously reported for the Arco wetlands region in the Namibe Province of Southwest Angola, appropriate inventories of geological heritage can assist the management of protected areas, including interactions with habitats and species, and also help provide adequate planning for their public use (Tavares et al., 2012). Geoconservation measures implemented in the Natural Park of Fogo

Island in the Republic of Cape Verde (Alfama et al., 2008) or the "seven-coloured earth" of Chamarel in Mauritius (Sheth et al., 2010) are eloquent examples of how to attract financial resources through geotourism and promote sustainable development in Africa.

This work represents a contribution towards supporting a political intervention with a local, regional, national and/or supra-national impact, leading to the preservation of the geological heritage of Tundavala as a component of the earth´s natural heritage, and underpinning the implementation of community tourism initiatives (Simpson, 2008), in which local and regional commitments are required (Bruno and Perrotta, 2012).

Taking into account the geological characterisation of the Tundavala site and its geoheritage contents and values described above, several geoconservation strategies and actions can be proposed in order to ensure its sustainable geoconservation (Fig. 12).

On a supra-national scale, the arguments advanced here can be used as the basis for an application for the inclusion of the Tundavala site in the UNESCO World Heritage List for Africa, considering that its geological record represent "major stages of earth´s history including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features", and that the resulting landscape "contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance" and is "directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance", thus meeting criteria 8, 7 and 6 respectively, of the selection criteria of the List (UNESCO, 2013). This would allow Angola to appear on the list for the first time, as well as increasing the representation of Africa, since "the continent of Africa is rich in both cultural as well as natural heritage with outstanding universal values. However the continent is still disadvantaged in that despite its great potential, it has the least sites on UNESCO´s World Heritage List" (AWHF, 2009). Moreover, by helping to tell the story of the continent, of Gondwana and of the earth, the Tundavala site can be also viewed, within the aims of the current "Africa Alive Corridors"

436 initiative, as a Heritage Node to be established within the Corridor 2: Snowball Earth (Namibia
437 to Angola) 1000-500 Ma: “From a lifeless snowball Earth to the biological big bang” (Toteu et
438 al., 2010).
439 On a national level, policy measures are required, namely the implementation of instruments
440 for the conservation and management of the natural heritage and, additionally, its geological
441 aspect, including those governing the creation of protected areas as prescribed in the
442 Environment Law Framework for the Republic of Angola. In fact, one of the goals of Law No.
443 5/98 of 19 June (Article 5(j)) is the establishment of clear and applicable rules to protect the
444 natural, cultural and social heritage of the country (MP, 1998), which have not yet been
445 approved.
446 Given the commitments made by the Member States of the Community of Portuguese-
447 Speaking Countries, particularly with regard to environmental protection, with a view to
448 promoting sustainable development and which appear in the body of its Constitutive
449 Declaration (CPLP, 1996), it is predictable and desirable that any future regulation of nature
450 conservation and biodiversity in Angola is likely to converge with a similar document published
451 by the Portuguese government which specifically addresses protection of the geological
452 heritage in the form of the Natural Monument (ICNF, 2013).
453 However, in addition to legal protection measures geoconservation requires the active
454 involvement of citizens, either individually or collectively, through the work of public and
455 private organisations which encourage the development of geotourism. As pointed out by
456 Dowling (2011), geotourism provides an opportunity for countries and regions to promote
457 their identity and helps publicise the geoheritage values that the respective territories possess,
458 with clear benefits for local communities. This study aims to contribute towards creating
459 partnerships involving academic research, local governance, businesses and/or non-profit
460 organisations, based on the geoheritage potential of Southern Angola, with a view to

implementing geotourism within the territory as an instrument of preservation and development (Martínez-Frías and Mogessie, 2012).

The valuation of sites displaying geological heritage implies the implementation of specific structures, which include accessibility, accommodation and services to enable them to be enjoyed, as well as the production and dissemination of resources for the general public that will help them to interpret the geological information (Mansur and Silva, 2011). In this context, the role of universities as institutions capable of contributing to the training of staff with specific skills in geoconservation is particularly important, not only in terms of designing and developing resources that allow for the valuation of the geological heritage but, in particular as the only stakeholder with the technical know-how required to propose sites for future classification as protected areas, as was the intention in this work.

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Figure Captions

Fig. 1 – View of Tundavala Gorge looking towards distant Namibe in the west.

Fig. 2 - View of the Tundavala plateau in the north-east.

Fig. 3 – Location of the Tundavala site and GOOGLE™ satellite image (2007).

Fig. 4 –The Tundavala belvedere, located at the top of the Tundavala Gorge.

Fig. 5 – Types of contents of geological objects with heritage value (based on Pena dos Reis and Henriques, 2009).

Fig. 6 - Methodology used to characterise the geological heritage of Tundavala, serving as a tool to support a classification proposal for the site, as well as to establish strategies for its conservation and valorisation (adapted from Bala, 2011; Henriques et al., 2012).

Fig. 7 - The stratigraphical record of the Chela Group outcropping at the Tundavala Cliff observed from Bibala (A); Stratigraphic column of the Chela Group at the Humpata Plateau (modified of Pereira et al., 2011). The dashed lines represent the outcrop boundaries and the dotted lines indicate the boundaries between the Tundavala/Humpata Formations and the Humpata/Bruco Formations (B).

Fig. 8 – Relevance of the Tundavala Gorge in documents on environmental and tourism themes (Instrument 2).

Fig. 9 - Frequency of graphic content included in documents on environmental and tourism themes (Instrument 2).

692

693 Fig. 10 - Frequency of graphic content included in web pages (Instrument 3).

694

695 Fig. 11 – Types of heritage content with the heritage values recognised in Tundavala, based on
696 Relevance Grade and Abstract Perceptiveness, as defined in Pena dos Reis and Henriques
697 (2005) (modified of Henriques et al., 2012).

698

699 Fig. 12 - Schematic representation of guidelines for an integrated strategy for the conservation
700 and management of Tundavala as a geological object with heritage value (adapted from Bala,
701 2011).

702

703

704 **Table Captions**

705

706 Table 1 - The frequency of keywords in text titles and text content included in publications on
707 environmental and tourism themes (Instrument 2).

708

709 Table 2 - Frequency of keywords, by analysis of category of textual content included in web
710 pages (Instrument 3).

711

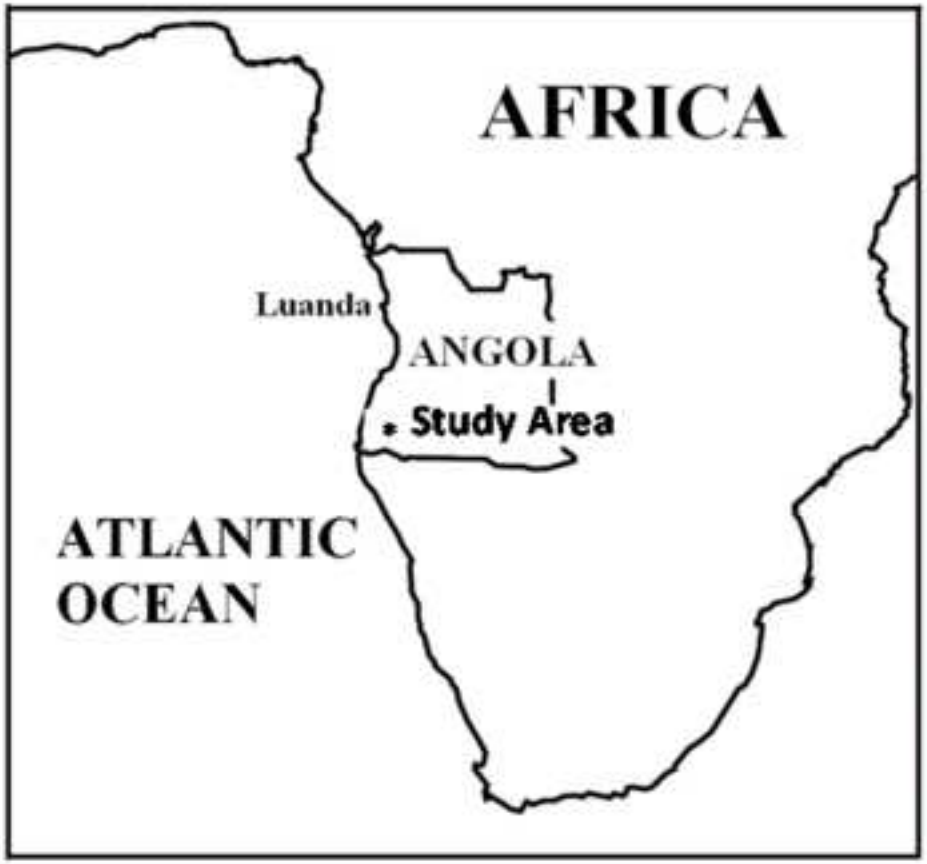
712

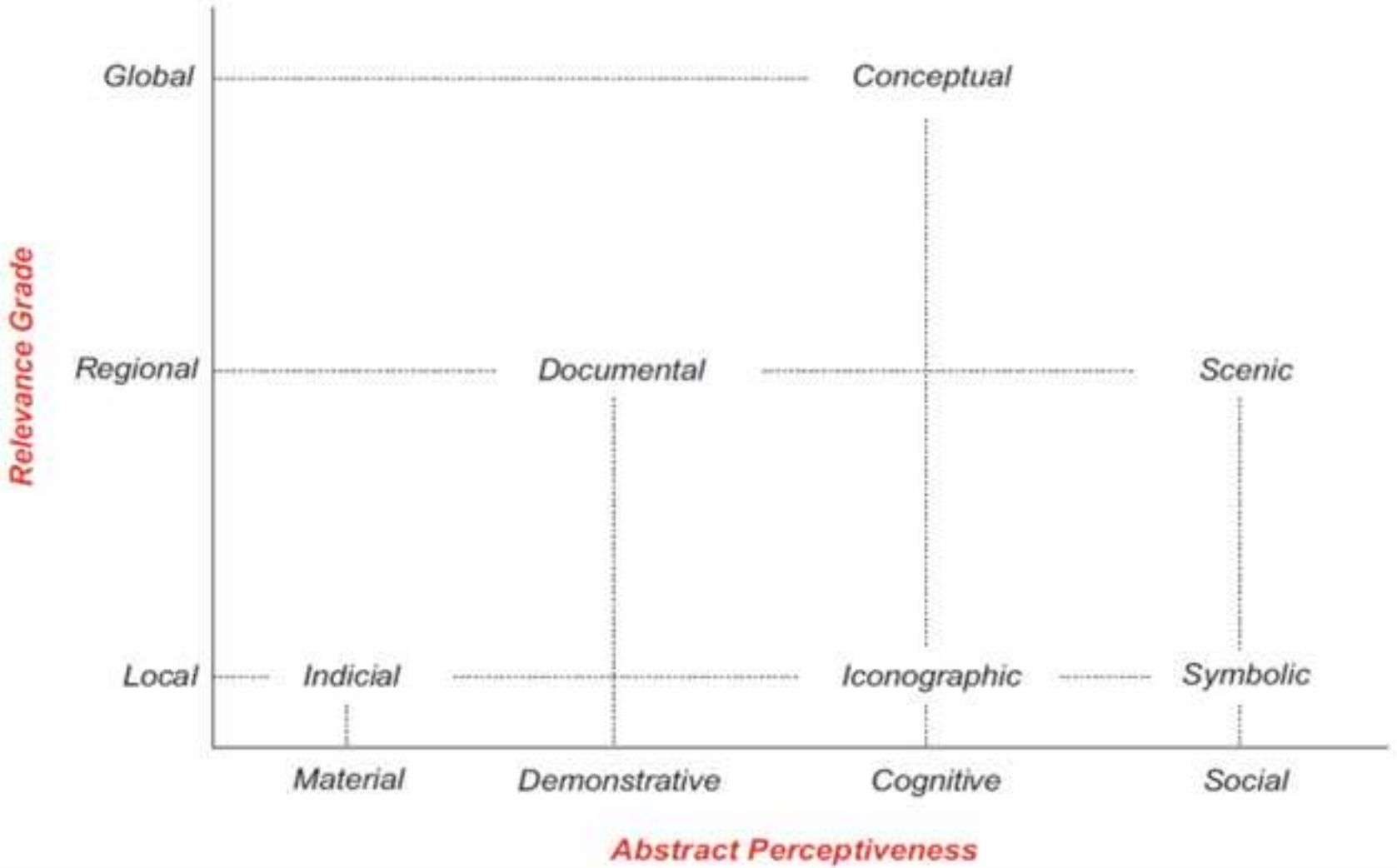
Table 1 - The frequency of keywords in text titles and text content included in publications on environmental and tourism themes (Instrument 2).

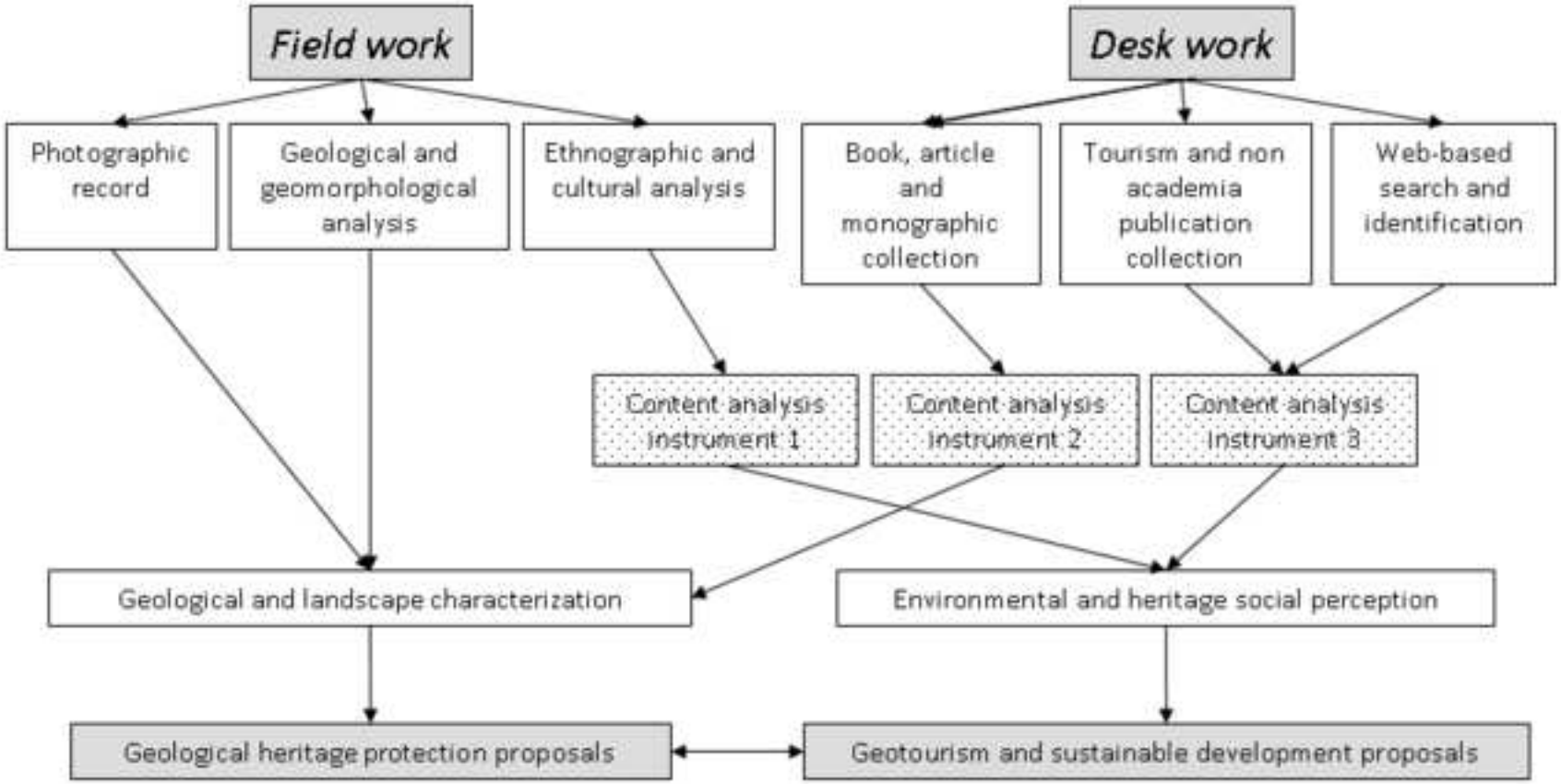
Keywords in text titles		Frequency		Frequency
	Tourism	5	Beauty	2
	Tours	2	Lubango	1
	Park	5	Richness	4
	Crevasse	3	Strategy	2
	Economy	4		
Keywords in text content		Frequency		Frequency
	Fascinating	3	Lubango	7
	Development	3	Crevasse	4
	Monument	2	Landscape	2
	Distribution	1	Imposing	6
	Economy	1	Belvedere	1
	Tourist attraction	5	Peace	1
	Appealing	2	Protection	3
	Visitor	1	Heritage value	2

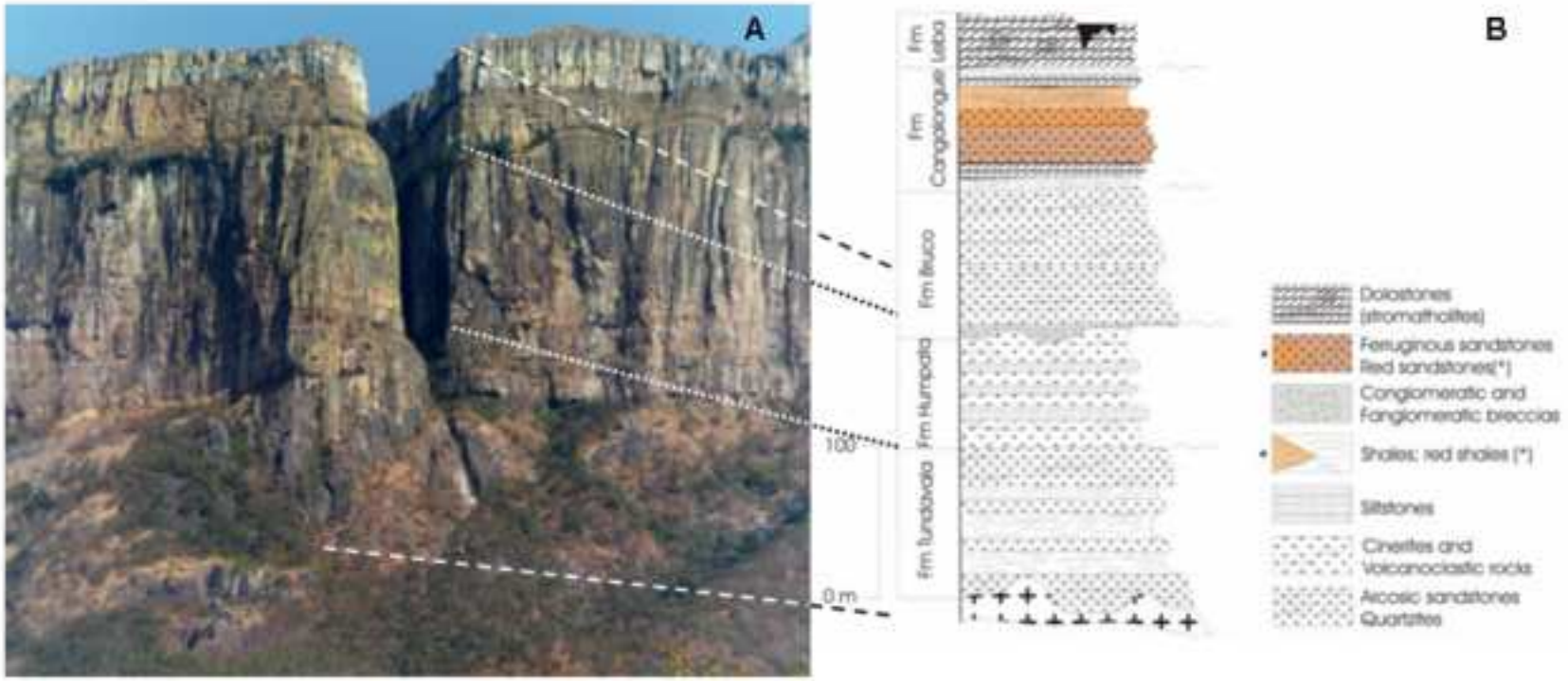
Table 2 - Frequency of keywords, by analysis of category of textual content included in web pages (Instrument 3).

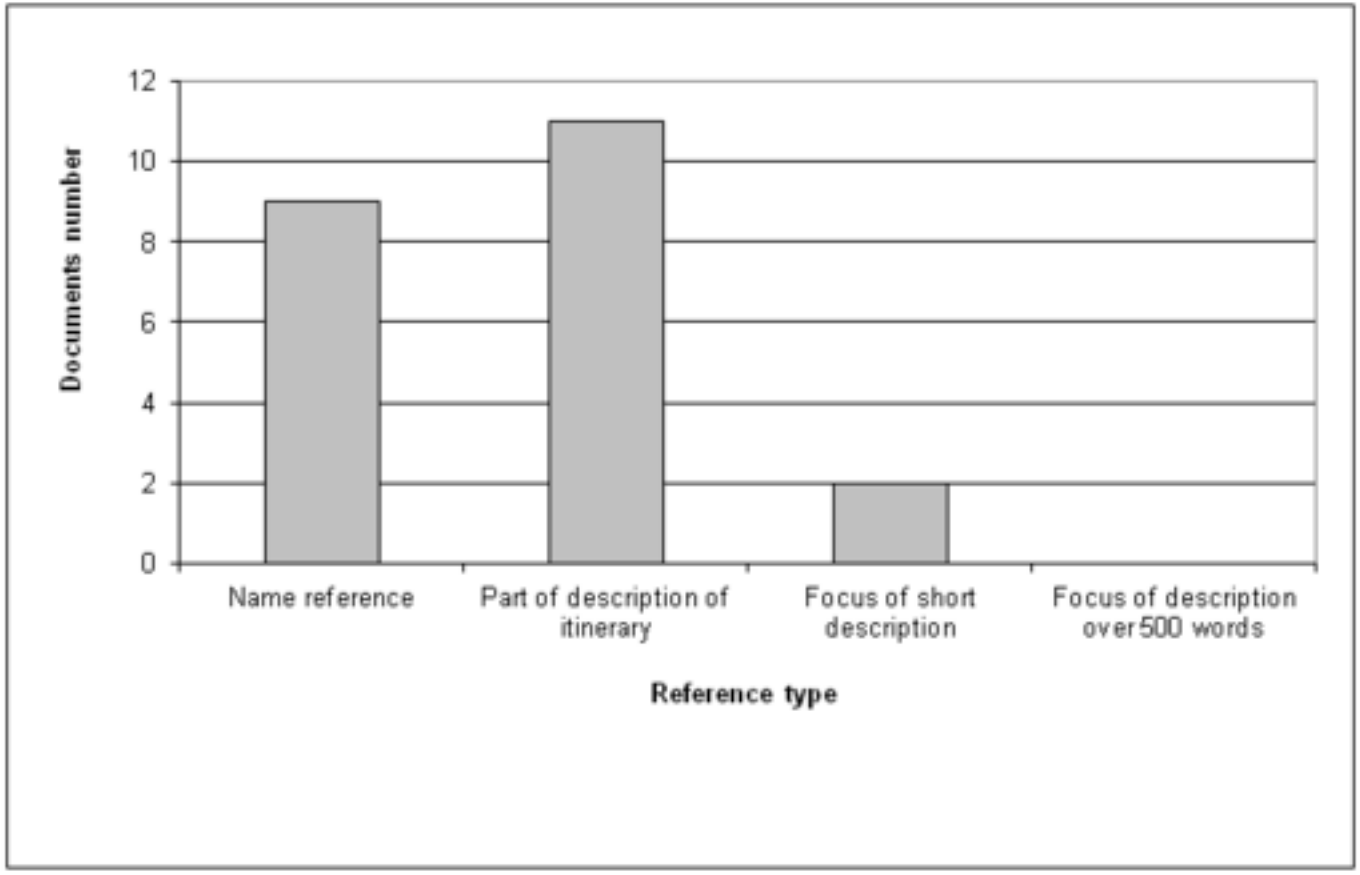
Keywords	Frequency	Keywords	Frequency
As name references			
Tundavala	9	Lubango	2
As an environmental element			
Crevasse	37	Mountain	3
Cliff	5	Hill	2
Cascade	4	Ridge	8
As displaying scenic qualities			
Wonder	4	Charms	5
Huge	2	Chill	1
Monument	14	Steep	1
Landscape	12	Magnificent	5
Impressive	3	Altitude	1
Abyss	6	Vertical cut	1
Luxuriant	1	Belvedere	1
Gorgeous	3	Attractive	1
Immense	2	Corner	1
Harmonious	1	Famous	3
Awe-inspiring	1	Cosy	7
As displaying economic value			
Revenue	8	Tourism	25
Potential	8	Tourist attraction	47
Potentiality	3	Benefit	8
Others			
War	9		

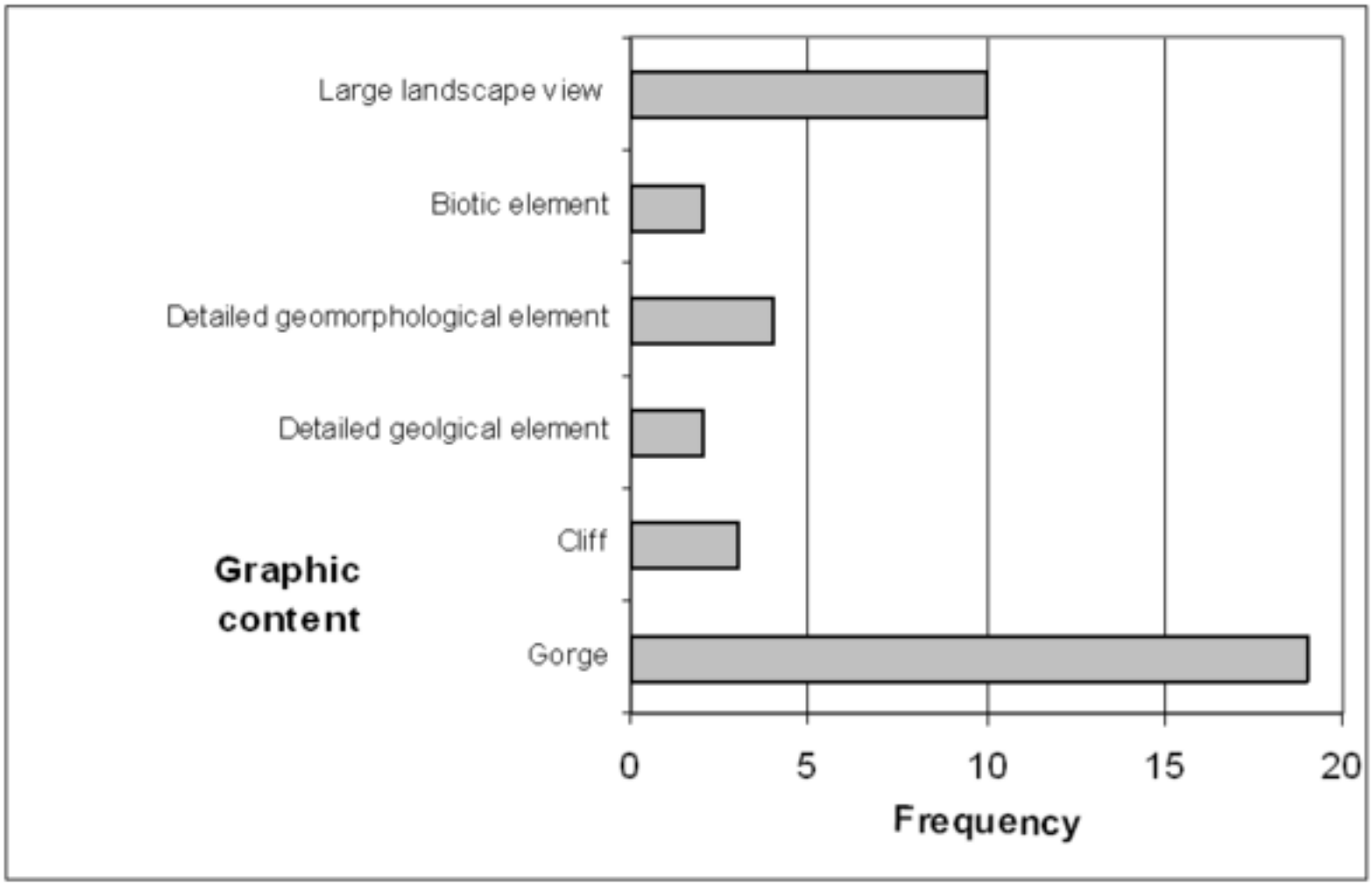


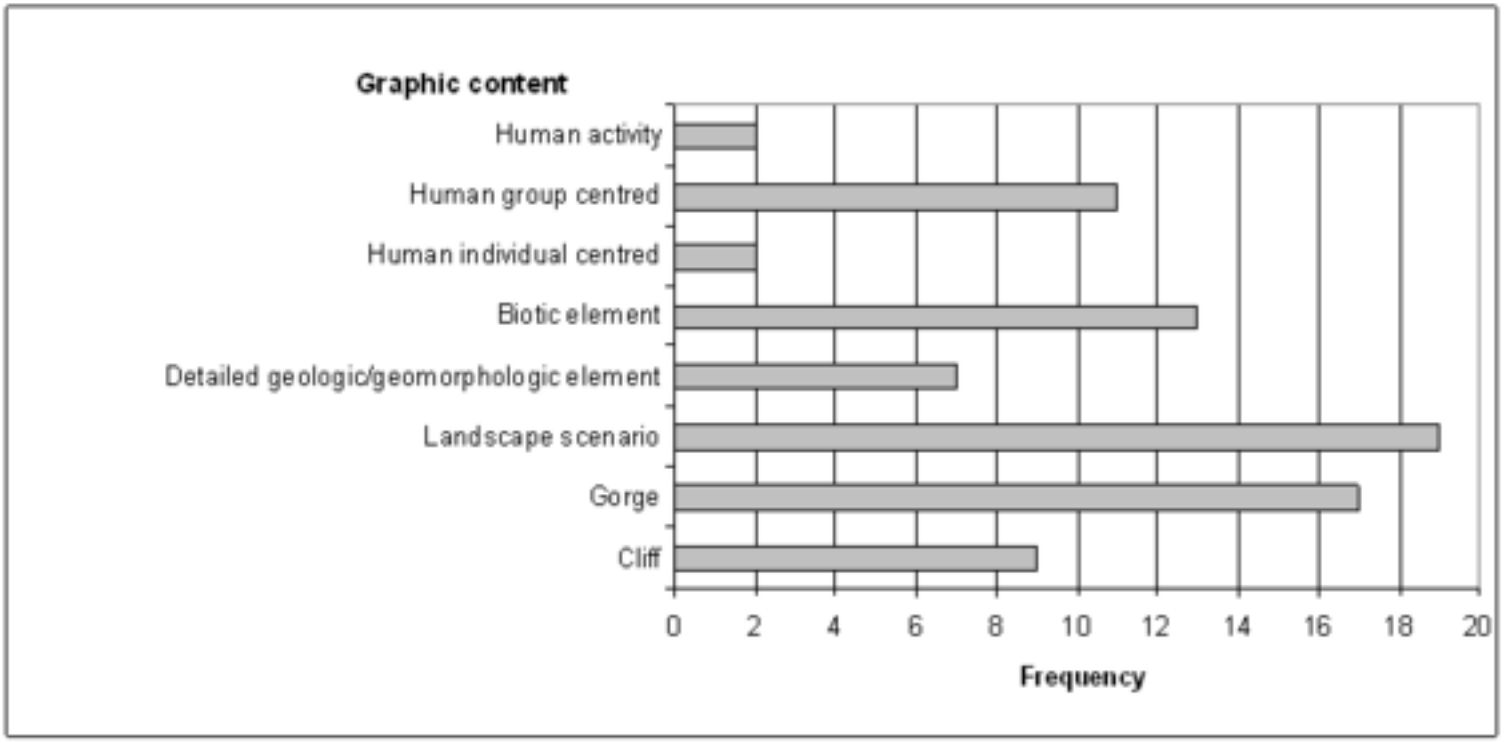


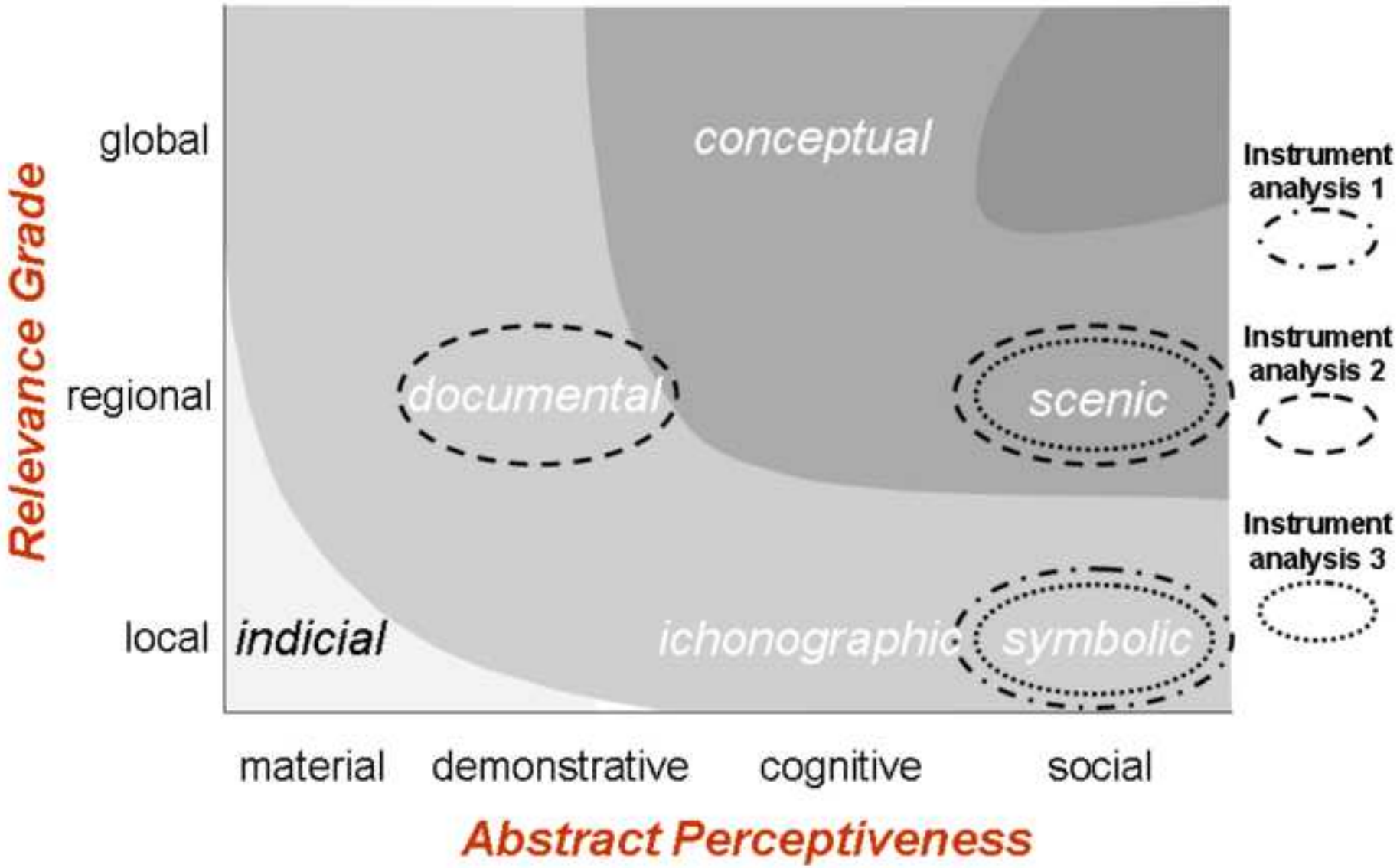











Relevance Grade
global
regional
local
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documental
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ichonographic
symbolic
Instrument analysis 1
Instrument analysis 2
Instrument analysis 3
material
demonstrative
cognitive
social
Abstract Perceptiveness