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REVIEW ARTICLE

Red Ereño: an Ornamental and Construction Limestone of International Significance from the Basque Country (northern Spain)

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Abstract
Red Ereño is widely prized as an ornamental and construction stone for its intense red micritic matrix, contrasting with the white rudist fossil shells it contains. Quarried since Roman times (first century) in the localities of Ereño and Gautegiz Arteaga, Red Ereño is a recognised limestone and has been widely used in architecture ever since. It was utilised extensively in the Basque Country and is characteristic of the urban landscape of several of the region's most important cities, including Bilbao and Gernika (Guernica). It has also been used in many monumental and other buildings throughout the Iberian Peninsula. Red Ereño limestone has also been exported to the Americas and Italy, the most significant example being its use in the flooring of St Peter's Basilica in the Vatican. This paper summarises the main features of Red Ereño as a candidate for consideration as a Global Heritage Stone Resource (GHSR). This recognition will be important for future research and restoration works of existing heritage buildings.

Keywords Red Ereño · Global Heritage Stone Resource · Heritage · Limestone

Introduction

Geology is an essential pillar in the research, study and conservation of heritage buildings (De Wever et al. 2017; Pereira and Cárdenes Van den Eynde 2019). The stones used in a city's construction and ornamentation play an important role in the urban landscape and confer character and identity on its buildings (De Wever et al. 2017; Freire-Lista and Fort 2019; Pereira and Cárdenes Van den Eynde 2019). Construction stones have traditionally been sourced from local quarries, giving each region a distinct character (De Wever et al. 2017). More recently, global development and usage have

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tended to blur these distinctive signs, leading to the development of standard-looking cities, whose appearance are governed more by commercial influences and fashion trends (Freire-Lista and Fort 2019). The geological recognition and mapping of construction materials related to local identity are particularly important when it comes to establishing planning criteria to protect the urban landscape of individual sites (Siegesmund and Török 2011; Freire-Lista and Fort 2019; Pereira and Cárdenes Van den Eynde 2019).

The Global Heritage Stone Resource (GHSR) designation confers international recognition on the main lithological types used in cultural heritage and construction (Cooper et al. 2013; Pereira and Marker 2016; Navarro et al. 2019). Candidates are assessed by the Heritage Stone Subcommission (HSS) of the International Union of Geological Sciences (IUGS). The criteria for evaluation are summarised on the www.globalheritagestone.com website (last accessed: June 2020) (Navarro et al. 2019).

The stone known as Red Ereño forms part of a thick succession of Urgonian (Aptian-Albian, Lower Cretaceous) limestones and outcrops in the Basque Country (northern Iberian Peninsula), just to the east of the Oka estuary in Gernika (Guernica) (Fig. 1a, b). Notable for its striking red matrix, it outcrops in a band running subparallel to the bedding at the base of the Aptian-Albian succession. The abundant fossil content, primarily comprising white rudists, gives the lithology an ornamental character that was highly valued from Roman times to the mid-twentieth century (Martínez Salcedo 1997; Damas Mollá et al. 2011, 2012, 2018; Damas Mollá 2011). Red Ereño has been widely used in the Basque Country and has marked the urban landscape of its cities. It has also been exported to numerous sites on the Iberian Peninsula (Fig. 1a), as well as to the Americas and Italy.

Red Ereño takes its name from the coloration of the micritic matrix of the rock and the locality where most of the quarries were located—Ereño (province of Biscay). Although geologically classified as a limestone, traditionally and for commercial purposes, it has been known as Red Ereño marble (IGME 1991). The stone's geoheritage importance is closely linked to its use as an ornamental rock. In 1990, the Provincial Government of Biscay declared Ereño marble an Item of Geological Interest (Ibarguchi and Bombín 1990) and it is now included in the Inventory of Geosites of the Autonomous Community of the Basque Country (Mendia et al. 2013; Gobierno Vasco 2015).

In this study, we list the main features of Red Ereño as an ornamental and construction stone, using HSS criteria. We are therefore submitting it for consideration to be designated as a GHSR for which it meets the necessary requirements.

Location

Red Ereño is quarried in the area surrounding the villages of Ereño and Gautegiz-Arteaga in Biscay province (Spain) (Fig. 1a). The limestone was originally quarried in small family-operated operations using traditional, century-old techniques. Technological developments led to the creation of a larger quarry, known variously as *Cantera Gorria* (Red Quarry), *Cantera Atzarraga* (Atzarraga quarry) or *Cantera Andrabide*

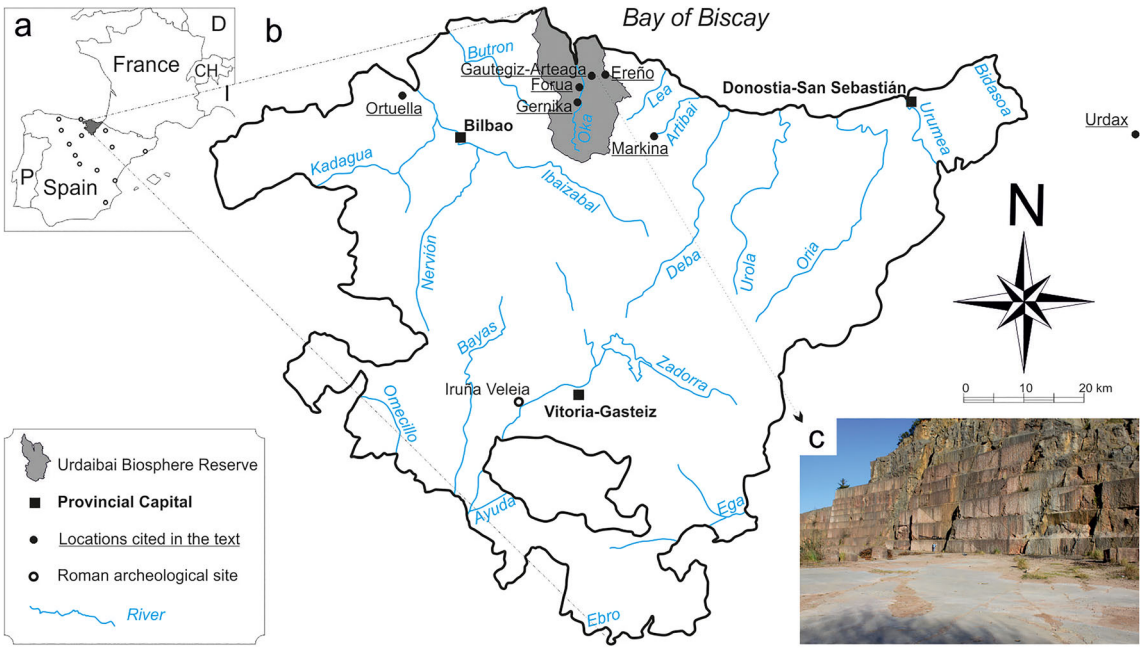

Fig. 1 **a** Geographical location of Red Ereño and location of some of the major cities on the Iberian Peninsula where Red Ereño is used in major buildings. **b** Autonomous Community of the Basque Country. **c** *Cantera Gorria* (Gautegiz-Arteaga/Ereño, Biscay province) (photograph by R Damas)

(Andrabide Quarry) (hereinafter referred to as *Cantera Gorria*), where helical steel wire was used (Damas Mollá et al. 2012). This quarry has now been abandoned and forms part of the historical heritage of the province of Biscay (Fig. 1b) (Diputación Foral de Bizkaia 2020).

All of the outcrop area of Red Ereño lies within the area of the Urdaibai UNESCO Biosphere Reserve, declared in 1984 for conservation of the Oka river estuary ecosystem (Gernika estuary) (Mendia et al. 2011) (Fig. 1b). In addition to its biological resources, the reserve also hosts an important geoheritage, including the Red Ereño limestones (Mendia et al. 2011, 2013). The regulation of the Urdaibai Biosphere Reserve includes the protection of sites of geological interest (Decree 139/2016 of 27 September) (www.euskadi.eus/y22-bopv/es/bopv2/datos/2016/11/1605040a.shtml; last accessed: November 2020) and promotes the importance of their conservation and recovery with a clear objective of educational and recreational use (DECREE 258/1998 of 29 September 1998) (www.euskadi.eus/bopv2/datos/1989/07/8902100a.pdf; last accessed: November 2020).

Geological Setting

The outcrop area is located in the northern Basque-Cantabrian Basin, an inverted Cretaceous rift basin to the north of the Iberian plate formed as a result of the opening of the Bay of Biscay (Boillot and Capdevilla 1977; Boillot 1984). The Urgonian limestone succession studied here forms part of the Basque Arc unit (Feuillée and Rat 1971). The Red Ereño limestones, of Aptian-Albian age, are part of the Santimamiñe Unit (Agirrezabala 1996). The unit has received several different denominations: Gernika rudist limestones and Ereño rudist limestones (Rat 1959); Lekeitio-Arno Formation (García-Mondéjar 1982); Busturia limestones (U1) (Robador 1984); Ereño limestones (Pascal 1984); Ereño reefal limestones (Reitner 1985); Perireefal bedded limestones (IGME 1989); and Urgonian complex (Garrote Ruiz et al. 1985). It corresponds to a homoclinal succession of micritic limestones with abundant fossil content, striking N110° E and dipping 85° to the N or subvertical. Its lower contact is the siliciclastic Acantilado de Otoio Formation (mainly sandstones) while its upper contact varies from place to place: Cuadro Formation (megabreccias, marls and calcarenites); Ondarroa Formation (turbiditic conglomerates, sandstones and lutites); Apikale Formation (sandstones and bioturbated calcareous lutites); and Deba Formation (turbiditic lutites and sandstones) (Fig. 2) (IGME 2009).

The matrix of the Santimamiñe Limestone Unit is generally grey in colour, with the exception of a red band running parallel to the bedding at its base. This intense red band, marketed commercially as Red Ereño, is 1500 m long and has a stratigraphic thickness of 166 m (Fig. 2). The Ereño limestone unit is massive but the bedding is marked by bioconstructions of bivalves in life position. Five facies have been identified, mainly based on the arrangement and size of the fossil content: (1) facies with entire polyconitid rudists or *Chondrodonta* sp. fossils in life position (Fig. 3); (2) facies with requienid rudists, *Chondrodonta* sp. and massive corals, containing entire shells but not in life position; (3) facies with diverse rudist shell fragments and corals of over 2 cm, with a high concentration of stylolitized matrix (Fig. 3); (4) facies with bioclasts of over 2 cm, but low proportion of matrix (as compared to the previous facies); and (5) facies with diverse and small bioclasts of under 1 cm (Damas Mollá 2011). Based on the facies associations of the red band identified in the field, both vertically and laterally, the depositional paleoenvironment may be characterised as a shallow isolated subtropical marine carbonate platform (Rat 1982; Damas Mollá et al. 2009). The diverse energy conditions in this platform favoured extensive development of polyconitid rudist thickets and monopleurid rudist bouquets in environments more exposed to high-energy processes, and the growth of requienid rudists and *Chondrodonta* sp. in more restricted areas. Damas Mollá (2011) also identified repetitive vertical sequences marked by the alternation of levels with fossils in life position (PBF) and levels of bioclastic accumulations related to storm events (SF) (Fig. 3).

Petrological and Mineralogical Characteristics

The most striking feature of Ereño limestone is its high content in macrofossils, mainly bivalves, with an abundance of rudists (polyconitids, monopleurids and requienids) (Fig. 4a and b) and *Chondrodonta* sp. (Fig. 4c) (Damas Mollá et al. 2004a, 2008b; Damas Mollá 2011). There are also abundant fragments of coral, as well as bioclasts of other organisms, such as bryozoans, gastropods, ostracods and echinoderms. The main allochems of the microfacies of this lithology are therefore the bioclasts of the aforementioned macrofossils, in association with abundant foraminifera (orbitolinids, miliolids and agglutinated encrusting foraminifera) (Damas Mollá 2011; Damas Mollá et al. 2012). These allochems are embedded in a massive micritic matrix (lime mud), with a high degree of packing and intense red colouration (Fig. 4d), particularly in areas affected by stylolitization. The rock displays intense diagenesis, and some sectors therefore present recrystallization of the micritic matrix into microsparite or sparite crystals (coarse crystalline calcite) in different crystallization phases, mainly resulting from neomorphic processes (Damas Mollá et al. 2004b; Damas Mollá et al. 2006a, b, 2008a).

Petrologically, this limestone has been classified as biomicrite (Folk 1962), wackestone/packstone (Dunham 1962) and framestone (Embry and Klovan 1971). Nevertheless, based on the size and position of bioclasts and

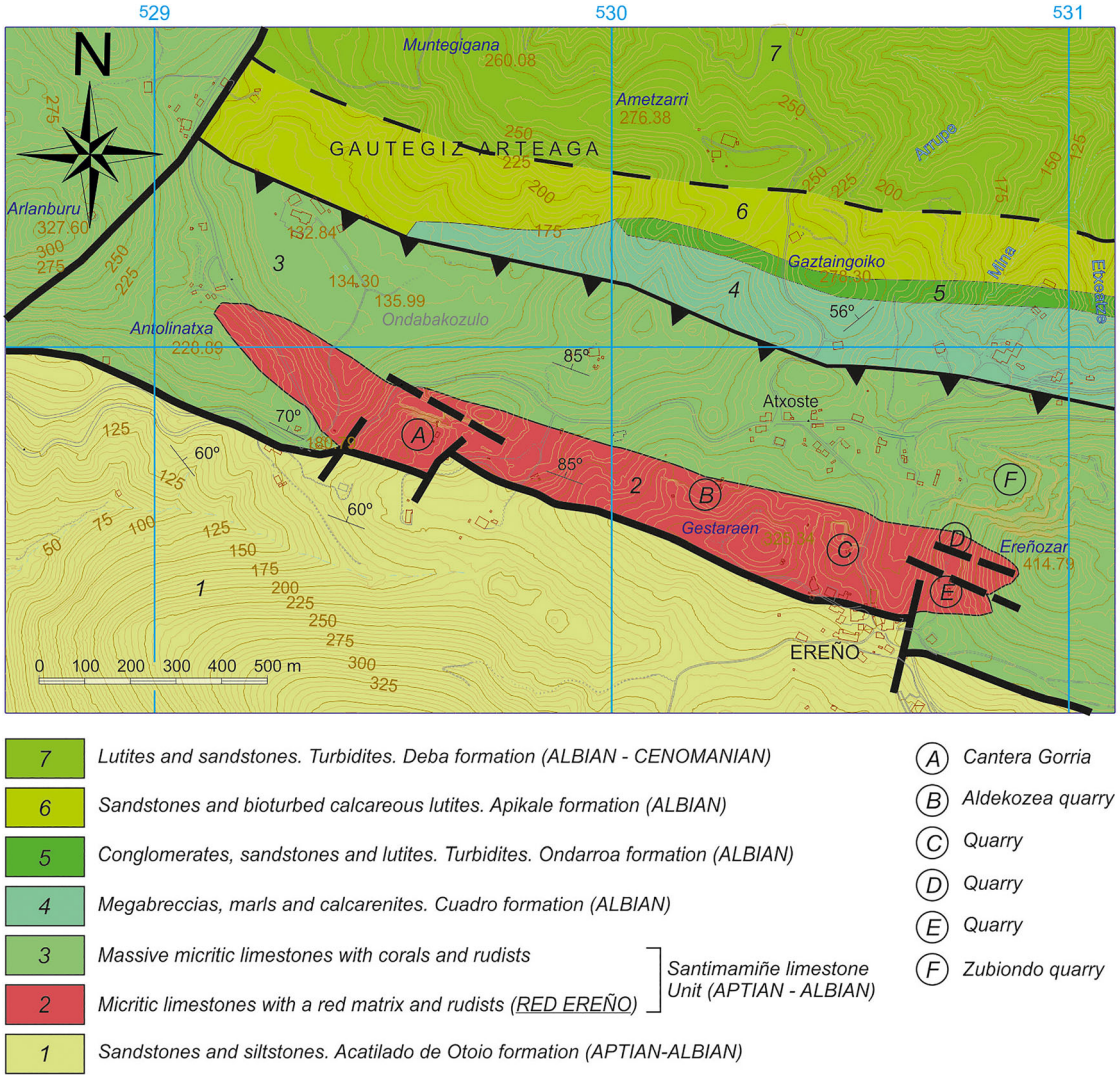

Fig. 2 Geological map of Red Ereño outcrop (after IGME 2009 and Damas Mollá 2011)

the matrix content, distinct sectors of the red band can be classified as (Damas Mollá et al. 2011) framestone (Embry and Klovan 1971) (Figs. 3, 4a); bafflestone including *Chondrodonta* sp. (Fig. 4c); boundstone of requienid rudists and *Chondrodonta* sp. (Embry and Klovan 1971) (Fig. 4b); floatstone (Embry and Klovan 1971); rudstone (Embry and Klovan 1971) and wackstone/packstone (Fig. 4d) (Dunham 1962), all with fragments of rudist, *Chondrodonta* sp., echinoderms, bryozoans, corals, oysters, gastropods and foraminifera.

By mineralogical content, calcite is the predominant mineral, accounting for up to 94% of the total, followed by quartz (3.4%), potassium feldspar and plagioclase (< 2%) and clay minerals (mainly illite and in some sectors, diagenetic chlorite). Despite the intense red colour of the matrix, the proportion of minerals such as haematite is smaller, at less than 1%. The haematite is very finely grained (ultrafine), pigmentary haematite, with a high capacity for dyeing (Damas Mollá 2011).

It should be noted that the red colour of the rock is present exclusively in the matrix; other fossil fragments are white, black or grey in colour, depending on the fossil type. This corresponds to entry of haematite in a later diagenetic phase, after the occlusion of the bivalve shells due to an early diagenesis (Damas Mollá et al. 2008b; Damas Mollá 2011).

Red Ereño Ornamental Stone

The Romans appear to have been the first to recognise the ornamental value of Ereño limestone. A funerary cippus (pedestal) from the first century and a votive *ara* (altar) from the late first or early second century were discovered at the archaeological site of Forua (Biscay province), a settlement lying close to the Ereño outcrops (9.8 km) (Fig. 1b) (Martínez Salcedo 1997; de Areitio 1906; Ybarra y Bergé 1955) (Fig. 5). The *ara* is now held in the Archaeological Museum of Bilbao

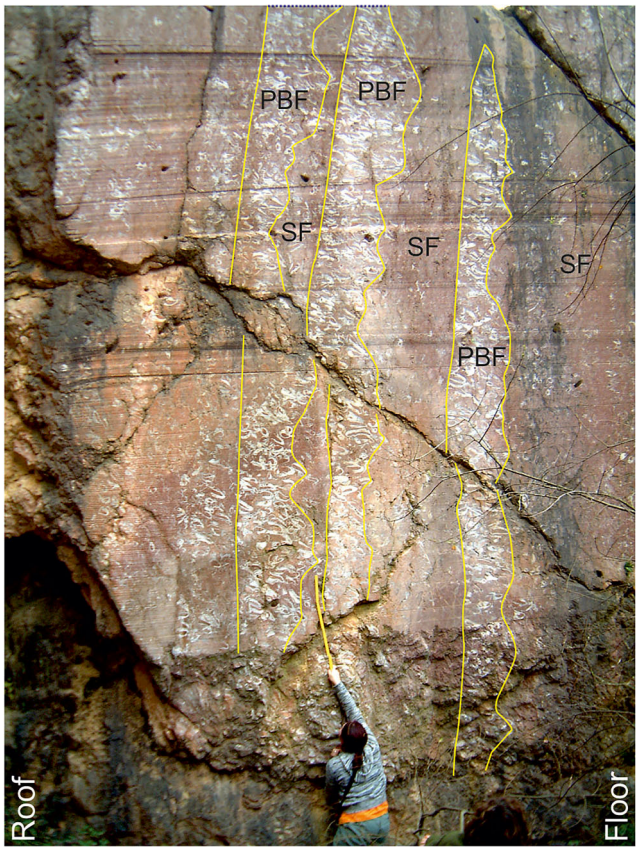

Fig. 3 Section perpendicular to the bedding at *Cantera Gorria*. Sequences composed of alternating bioconstructed polyconitid rudists (PBF) and storm facies (SF) can be seen

(Arkeologi Museoa). It was previously housed at the entrance to the church at Forua (Biscay) and used as a stoup for holy water, before being replaced with a replica. Commercialisation of Red Ereño in Roman times is evidenced by its use in more distant locations such as the Roman Iruña-Veleia archaeological site (Araba province, 101 km from the Ereño outcrops) (Fig. 1b) (Damas Mollá 2011).

Large-scale exploitation began in the late nineteenth century, with the creation of small family-run quarries with faces of no more than 20 m. One example is the Aldekozea family quarry (active from 1947 to 1974), in the Atxoste district of Ereño village, which still displays several quarrying marks and numerous remains of machinery (Fig. 6a). Despite advances in quarrying techniques, human intervention was essential during this period (Fig. 6b). Work at the largest and best-known quarry, the *Cantera Gorria* (coordinates: 43° 21′ 34″ N 2° 37′ 59″ W) (Fig. 1b), is documented since 1890 (Damas Mollá 2011). The quarry's last owner was *Marmolería Bilbaína* S.L., which operated it from 1968 to 1989. The abandoned quarry now forms part of the historical heritage of the Biscay province (Diputación Foral de Bizkaia 2020). Quarrying of Red Ereño ceased in 1989 (Damas Mollá et al. 2012), although a reserve block remains at *Cantera Gorria*, which could be used in restoration work to replace damaged pieces. The land is owned by the municipal authorities and exceptional extractions could therefore be permitted if required for reconditioning items of historical heritage.

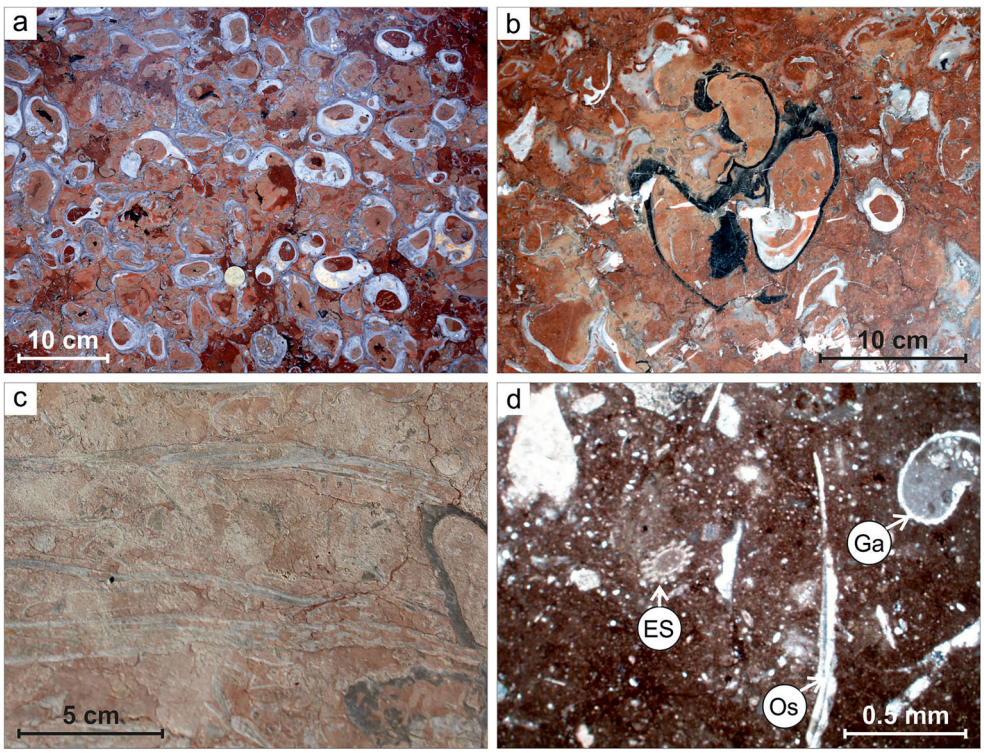

Fig. 4 **a** Polished slab of Red Ereño, transverse cut of polyconitid rudist framestone. **b** Polished slab of Red Ereño with requienid rudists. **c** Transverse sections of *Chondrodonta* sp. shells, located in the *Cantera Gorria* front. **d** Microphotograph with polarised light of Red Ereño in thin section, with abundant fossil content (echinoderm spine: ES; ostreyd: Os; gastropod: Ga)

Fig. 5 Votive *ara* in Red Ereño dating from the late first or early second century, discovered at the archaeological site of Forua (Biscay province). Photograph of the item preserved in the Arkeologi Museoa (Archaeological Museum of Biscay) by Santiago Yaniz

The unusual aesthetic appeal of Red Ereño, combined with its mechanical strength (Table 1) and smoothness for sculpting purposes, has given it significant ornamental value. Its most singular feature is its red micritic matrix. Based on CIE (International Commission on Illumination) standards, it has values of D65 illuminants and an angle of 10° of L*32.46 a* 11.11 b* 9.78. Average RGB values are 96, 68 and 61, respectively, but the colour varies depending on the point of measurement. The natural variability of the lithology depends primarily on two aspects: (1) the type of facies extracted—fossil fragments or bioconstructed facies (Fig. 3); and (2) the cutting orientation of the blocks in the bioconstructed facies. The appearance of the limestone can vary greatly depending on whether it is cut longitudinally (Fig. 3) or transversally (Fig. 4a) to the main growth axes of the fossils, particularly the polyconitid rudists, with the transversal cut the most valued and recognised type for use as an ornamental stone (Damas Mollá 2011).

Red Ereño can be used as an ornamental stone, both in buildings (flooring, tiles, decoration, columns) and in works of art (sculptures, fountains). It can be used in both interiors and exteriors. It is commonly used in construction and stonework. It allows for several finishing techniques, ranging from very fine polishing (Damas Mollá et al. 2018), to pointing, bush hammering or honing.

Red Ereño's chief vulnerability for use as an ornamental and construction stone is the alteration caused by pollution and atmospheric agents. When located outdoors, it suffers noticeable differential weathering and surface discolouration of the micritic matrix. The latter, however, can be corrected with a fine polish, which causes minimal wear (Damas Mollá et al. 2018).

Red Ereño has been extensively used as an architectural and decorative element in the province of Biscay, where it has conditioned the urban landscape. It was widely utilised in the construction of significant buildings in Bilbao (Fig. 1b), including the Arriaga Theatre (1890) (Aranburu et al. 2009); the *palacio* of Victor Chávarri (1888), now the headquarters of the Civil Government, with profusely decorated carvings and finishes (Aranburu et al. 2009) (Fig. 7a); and

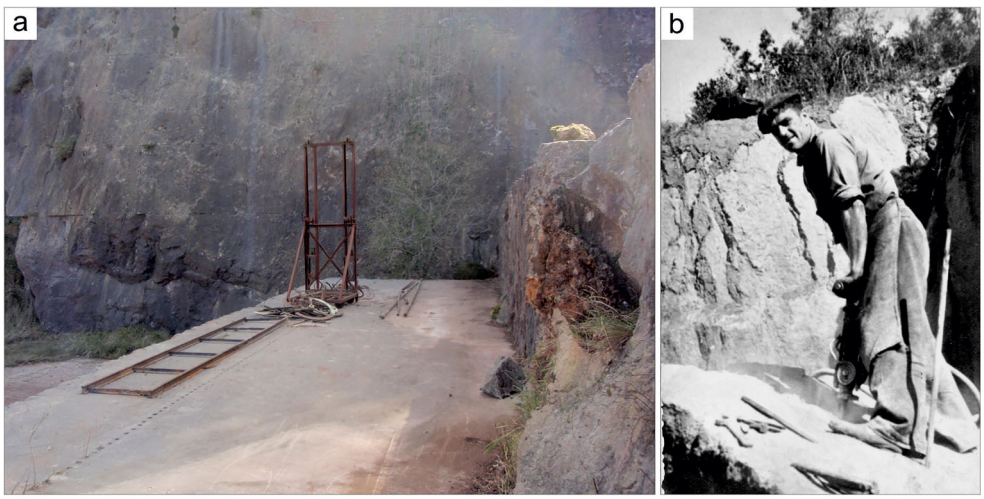

Fig. 6 **a** The Aldekozea Quarry today (Biscay province). Support and rail for the pneumatic hammer used for drilling. **b** Pedro Aldekozea working at the quarry in the early twentieth century (photograph by L. M Aldekozea)

Table 1 Information requested for inclusion of Red Ereño as a candidate for GHSR, based on the criteria established by the HSS (www.globalheritagestone.com, last accessed June 2020) (Cooper et al. 2013) (*for location, see Fig. 1; **taken from IGME 1991)

Nomination of Red Ereño for Global Heritage Stone Resource designation					
Name	Formal name	*Red Ereño (Rojo Ereño)*			
	Origin of name	The name reflects the colouration of the micritic matrix of the rock and the location where most of the quarries were located, Ereño (Biscay, Spain)			
	Stratigraphic name	Ereño Red limestones; Ereño limestones; Urgonian complex			
	Other names	Ereño Red Marble; Red Bilbao (Rojo Bilbao)			
Location	Area of occurrence	Ereño and Gautegiz-Arteaga (Biscay, Spain)			
	Principal location of quarry or quarries*	*Cantera Gorria* (Red Quarry), *Cantera Atzarraga* (*Atzarraga* Quarry) or *Cantera Andrabide* (*Andrabide* Quarry) 43° 21′ 34″ N 2° 37′ 59″ W			
Geology	Geological age	Early Cretaceous (Aptian-Albian)			
	Geological setting	Red Ereño forms part of the Urgonian Unit of Santimamiñe limestones in the Basque-Cantabrian Basin. The series corresponds to a homocline of approximately east-west direction (N110° E) with a subvertical dip of about 85°. The mineralized red band runs parallel to the bedding at its base where rudist bivalve fossils are abundant.			
	Petrographic name	Biomicrite (Folk 1962), rudstone, boundstone (Dunham 1962) and framestone (Embry and Klovan 1971)			
	Mineralogy	Calcite (94%); quartz (3.4%); potassium feldspar and plagioclase (< 2%); clay minerals (< 5%); pigmentary haematite (ultrafine) (< 1%)			
Physical properties**	Bulk specific gravity	2.71 g/cm^3	Bending strength	187 kg/cm^2	
	Apparent porosity	0.37%	C. strength after freezing test	769 kg/cm^2	
	Absorption coefficient	0.13%	Frictional wear test	3.10 mm	
	Compression strength	739 kg/cm^3	Impact test	45 cm	
Colour	Primary colour	L* 33.02 a* 31.10 b* 20			
Natural variability	Variability	1) The type of facies quarried, which may be composed of either fossil fragments or bioconstructed facies; 2) The cutting orientation of the blocks in the bioconstructed facies. The appearance of the limestone can vary greatly depending on whether it is cut longitudinally or transversally to the main growth axes of the fossils, particularly the polyconitid rudists. The transversally cut stone is more valued and recognised for its use as an ornamental stone.			
Ornamental or building stone	Suitability	Red Ereño can be used as an ornamental stone, both in buildings (flooring, tiles, decoration, columns) and also in artwork (sculptures, fountains). It can be used both as an interior and exterior feature. It is commonly used in construction and stonework.			
	Finish	Several finishing techniques are used, ranging from very fine polishing (Damas Mollá et al. 2018), to pointing, bush hammering and honing. The stone has been commonly used in highly ornamented structural elements.			
	Vulnerability	*Natural*: differential weathering and the superficial discolouration of the micritic matrix. Polished stone can be corrected with a fine polish, causing minimal wear. *Anthropic*: loss of identity due to indiscriminate replacement with other decorative stones, in keeping with the fashion standards of the time in reconditioning works.			
	Maintenance or supply	Remaining blocks at *Cantera Gorria*; land publicly owned.			
Historic use and geographic area of utilization	First uses	Roman period, late 1st or early 2nd century (Forua, Biscay)			
	Exploitation	Twentieth century (1989)			
	Geographic area	Intensive use: Basque Country (Spain). Export: Iberian Peninsula, Americas and Italy.			
	Buildings and artworks*	*FORUA*: Roman votive *ara* (first century). *BILBAO*: Basilica of Begoña (1511-1621); Iturribide fountain (1728, restored in 1894); Víctor Chávarri Palace (1888); Arriaga Theatre (1890); Bilbao Philharmonic Society (1904); Sociedad Bilbaína building (1913); Pedestal of statue of Don Diego López de Haro (1938). *GERNIKA*: Casa de Juntas (1826); Santa Clara convent (1890); Pedestal of statue of Don Tello (1966). *GETXO*: Punta Begoña galleries (1918). *EREÑO*: San Miguel Church (1560, re-stored several times). *GAUTEGIZ-ARTEAGA*: Arteaga Castle (1859). *BARAKALDO/SESTAO*: La Punta del Carmen Bridge over the *Galindo* river (1890). *ORTUELLA*: Monument to the Miner by Lucas Alcalde (1990). *DONOSTIA/SAN SEBASTIÁN*: Santa Catalina Bridge (1870). *VALLADOLID*: School of Medicine (1889); *SEGOVIA*: Royal Palace of La Granja de San Ildefonso (1724). *MADRID*: Palacio de las Cortes (parliament building) (1843). *ASTURIAS*: Basilica of Santa María la Real in Covadonga (1901). *MURCIA*: Parliament of Murcia (reformed in 1987). *ITALY*: St Peter's Basilica in the Vatican (1626). *AMERICAS*: Colón theatre in Buenos Aires (Argentina) (1908). Numerous private, religious and civil buildings throughout the Iberian Peninsula and the Canary Islands.			

Table 1 (continued)

Nomination of Red Ereño for Global Heritage Stone Resource designation		
Other data	Related dimension stones	Red Baztan (Urdax, Navarra); Black Markina (Markina, Biscay)
	Related heritage issues	ICI (Items of Cultural Interest); World Heritage Sites (UNESCO)
	Main literature	De Areitio (1906); Ibargutxi and Bombín (1990); IGME (1991); Martínez Salcedo (1997); Damas Mollá et al. (2004a, b); Damas Mollá et al. (2006a, b); Damas Mollá et al. (2008a, b); Aranburu et al. (2009); Damas Mollá et al. (2009); Damas Mollá et al. (2011); Damas Mollá (2011); M. Mendia et al. (2011); Damas Mollá et al. (2012); Damas Mollá et al. (2014); Damas Mollá et al. (2018).

the Sociedad Bilbaína building (1913), which has large Red Ereño columns (Fig. 7b). It also features prominently in the basilica of Begoña (Bilbao), where it was used in the decoration of the main altar and an eighteenth-century baptismal font (Fig. 7c). Numerous other public and private buildings sport decorative features in the stone, including the vestibule of the Bidebarrieta public library and the headquarters of the Philharmonic Society of Bilbao (1904) (Fig. 7d). Other Red Ereño urban features in the city include the Iturribide fountain (built in 1728 and restored in 1894).

Red Ereño is not only representative of Bilbao; however; it was commonly used throughout the rest of the Autonomous Community of the Basque Country (Fig. 1b), in public heritage buildings, private edifices and homes. In Gernika/Guernica (province of Biscay), for example, the *Casa de Juntas* (Assembly Hall) (1833), the pedestal of the sculpture of Don Tello (the town's founder) (1966) and the Church of the Convent of Santa Clara (1890) all contain decorative elements in Red Ereño. In the city of Donostia-San Sebastián (province of Gipuzkoa), the Santa Catalina bridge (1870) also has decorative features in this stone. One of the most recent ornamental elements in Red Ereño is the Monument to the Miner in Ortuella (Biscay), erected in 1990 (Fig. 8) (Damas Mollá 2011; Damas Mollá et al. 2012).

Red Ereño was exported throughout the Iberian Peninsula (Fig. 1a), and can be found in the outdoor paving at the Basilica of Santa María la Real in Covadonga (Asturias); decorative features at the Granja de San Ildefonso Palace in Segovia (1724); the interior flooring of the School of Medicine at the University of Valladolid (1889) and the

Fig. 7 Buildings in Bilbao featuring Red Ereño. **a** Façade of the Víctor Chávarri *palacio*. **b** Sociedad Bilbaína building with a detail of a column at the top of the picture. **c** Baptismal font in the Begoña Basilica. **d** Vestibule of the Bilbao Philharmonic Society building with detail at the top of the picture

Fig. 8 Monument to the Miner by Lucas Alcalde (Ortuella, Biscay)

Fig. 9 Flooring of the main entrance of the St Peter's Basilica in the Vatican (Italy) (photograph by students of the Experience Classes (*Aulas de Experiencia*) of the University of the Basque Country UPV/EHU and M. J Mollá)

Palacio de las Cortes (parliament building) in Madrid (1843). Other examples may be found in Andalusia, Catalonia, Castilla-La Mancha, Murcia, the Canary Islands and Valencia. It was so prized as an ornamental stone that it was chosen to form part of the ornamental marble mosaic in the paving at the entrance to St Peter's Basilica in the Vatican (Italy) (1626) (Fig. 9) (Damas Mollá 2011; Damas Mollá et al. 2012, 2018). Red Ereño also features in some important buildings in the Americas, including the Colon Theatre in Buenos Aires, Argentina (1908), where it forms part of the exterior ornamentation of the so-called Widows' Box. A number of the most representative buildings and elements built in Red Ereño are listed in Table 1. Most of these monuments are officially protected under Spanish legislation as Items of Cultural Interest (ICIs). Some are also listed UNESCO World Heritage Sites, namely the Granja de San Ildefonso Royal Palace (declared in 2001) and St Peter's Basilica in the Vatican (declared in 1984).

Red Ereño can be related to other Urgonian limestones quarried throughout the Basque Autonomous Community and Navarre, which, despite coming from different stratigraphic units, display similar features. Markina Black (known commercially as *Negro Markina* or Markina marble) is much valued in both construction and ornamentation. It is quarried in the environs of the town of Markina (Biscay province) (Fig. 1b) and is notable for its micritic matrix, naturally dark grey in colour, which polishes to an intense black. The fossil content mainly consists of tabular and hemispheric corals, orbitolinids and bivalves (*Chondrodonta* sp. and rudists) (Damas Mollá et al. 2012, 2014). This lithology has been combined with Red Ereño in many buildings. Another example is the ornamental stone sold commercially under the name of *Red Baztan* which was quarried until the early twenty-first century in the locality of Urdax-Urdazubi (northern Navarre province, Spain). This stone is very similar in appearance to Red Ereño, with a red micritic matrix (albeit with a somewhat more violet tone) and abundant rudist fossils (Damas Mollá et al. 2005a, b; Damas Mollá et al. 2013). However, the appearance and families of rudists found in *Red Baztan*, mainly caprinids and radiolitids, differ from those of Red Ereño. Because of their great similarity, *Red Baztan* was used in many reconditioning works to replace Red Ereño flagstones. One important consequence for the conservation of Red Ereño as part of the built heritage has thus been the loss of its identity in some buildings where reconditioning works did not respect the original stone. More recently, Red Ereño has been indiscriminately replaced by other decorative stones in keeping with the fashion standards of the time, with no consideration for its heritage value. Designation of Red Ereño as a GHSR would ensure protection of the most outstanding heritage elements.

Global Heritage Stone Resource Designation

Table 1 summarises the information required for Red Ereño's candidacy as a GHSR, based on the criteria established by the HSS (www.globalheritagestone.com, last accessed June 2020) (Cooper et al. 2013).

Discussion and Conclusions

Red Ereño, used as an ornamental or construction stone, fulfils the necessary criteria for successful candidature for designation as a Global Heritage Stone Resource (GHSR) (Marker 2015). The principal reasons are as follows:

- Red Ereño has been used for more than 50 years. The oldest identified ornamental and architectural elements built using this stone date from the late first–early second century.
- Decorative and construction elements are geographically dispersed, not only in the Iberian Peninsula, but also elsewhere in Europe—as in the case of St Peter's Basilica in the Vatican—and in the Americas (the Colón Theatre in Buenos Aires).
- It has been used in numerous public and private buildings. Its presence is usually a mark of distinction.
- Its use in distinctive ornamental elements, fountains, pedestals of sculptures, highly ornamented structural features and indoor facings marks this stone out as a cultural icon. In addition, its common usage throughout the province of Biscay confers a national identity on the stone, linked to the architecture of different expansion phases.
- Exploitation at the main quarries has now ceased, but there is still remaining material cut into blocks at the quarries. Moreover, ownership of the main quarry is public, meaning that requests for exceptional extractions for reconstruction of historical heritage would be entertained.
- Although the rock and its outcrops—in particular the main quarry—are already inventoried as a geosite, and also as part of the historical heritage, designation of this lithology as a GHSR would provide important support for research and dissemination of the geology associated with the urban landscape and architecture. It would also favour preservation of the stone in certain architectural elements that are currently at risk due to building restoration projects.

In this study, we have mentioned the criteria requested by the Heritage Stone Subcommission (HSS) for inclusion of a rock as a GHSR. As discussed above, Red Ereño fulfils these criteria, and we therefore submit its candidacy for designation as a GHSR.

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Data Availability Not applicable.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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