# Hunter-gatherers, biogeographic barriers and the development of human settlement in Tierra del Fuego

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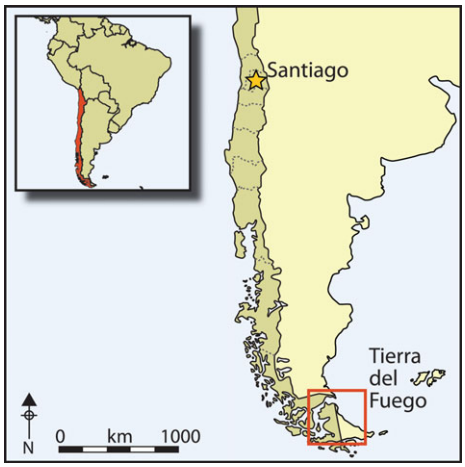


*Tierra del Fuego represents the southernmost limit of human settlement in the Americas. While people may have started to arrive there around 10 500 BP, when it was still connected to the mainland, the main wave of occupation occurred 5000 years later, by which time it had become an island. The co-existence in the area of maritime hunter-gatherers (in canoes) with previous terrestrial occupants pre-echoes the culturally distinctive groups encountered by the first European visitors in the sixteenth century. The study also provides a striking example of interaction across challenging natural barriers.*

*Keywords:* Patagonia, Tierra del Fuego, Holocene, human dispersal, hunter-gatherers, barriers, interactions, canoes

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## Introduction

The archaeology of sea barriers comprises a variety of situations, many of which concern the colonisation of oceanic islands (Cherry 1981) or particularly difficult crossings like the Strait of Gibraltar (Derricourt 2005). In contrast, Tierra del Fuego (52°–55°S), located in southernmost South America, was intermittently joined to the Patagonian mainland until *c*. 8000 BP, when it became an island. The significance of Tierra del Fuego for global archaeology lies both in being the southern limit of human dispersal in the Americas, and in having been home to culturally distinct terrestrial and maritime hunter-gatherer groups that persisted until the twentieth century AD. In this paper we summarise extant knowledge about the earliest human occupation of the island and discuss existing and new evidence for long-distance interaction during its subsequent human occupation.

## Island Tierra del Fuego

After the Last Glacial Maximum (*c*. 25 000–23 000 BP) glaciers re-advanced on two occasions, generating windows of opportunity for early people to migrate from Patagonia to Tierra del Fuego (McCulloch & Morello 2009). After *c*. 10 315 BP, Early Holocene warming led to the rapid retreat of the Patagonian ice fields but global sea levels continued to be approximately 20–60m below present-day sea levels, forming a land bridge across what today is an inter-oceanic passage, the Strait of Magellan. This situation persisted until the start of marine incursion, at *c*. 8300–7500 BP (McCulloch *et al.* 2005).

The main island of Tierra del Fuego, Isla Grande de Tierra del Fuego, today is over 250km long and 400km wide (Figure 1). The north-central zone is dominated by plains and rolling hills and the southern part is shaped by the Darwin Cordillera, an extension of the Andean range. A mean annual temperature of 5°C and rainfall of around 400mm per year reflect the influence of the Westerlies (Pisano 1977). Among the noteworthy Holocene fauna are guanaco (*Lama guanicoe*), fox (*Dusicyon culpaeus*) and rodents, in particular coruro (*Ctenomys* sp). The low density of terrestrial mammals is supplemented by permanent and seasonal marine and terrestrial birds, e.g. caiquen (*Chloephaga picta*), albatros (*Diomedea melanophris*) and penguin (*Aptenodytes patagonicus*, *Spheniscus magellanicus*), as well as by marine mammals such as sea lions (*Otaria flavescens* and *Arctocephalus australis*) and cetaceans, along with fish and mollusks. Broadly speaking, the northern half of the island is dominated by open vegetation while the southern half is characterised by southern beech forest.

## The view from ethnography

Nomadic hunter-gatherers were observed inhabiting the region from the first European sighting of the Strait of Magellan in 1520. Ethnographic accounts record two distinct groups in Tierra del Fuego and mainland Patagonia: maritime hunter-gatherers (Alacalufe/Kaweskar and Yamana/Yagan) were skilled navigators who relied on bark canoes but rarely ventured far inland (their archaeological record of shell middens first appears in the region around 6500 BP (Legoupil & Fontugne 1997). Terrestrial hunter-gatherers (Tehuelches/Aónikenk and Selk'nam/Ona in Tierra del Fuego) were averse to using vessels

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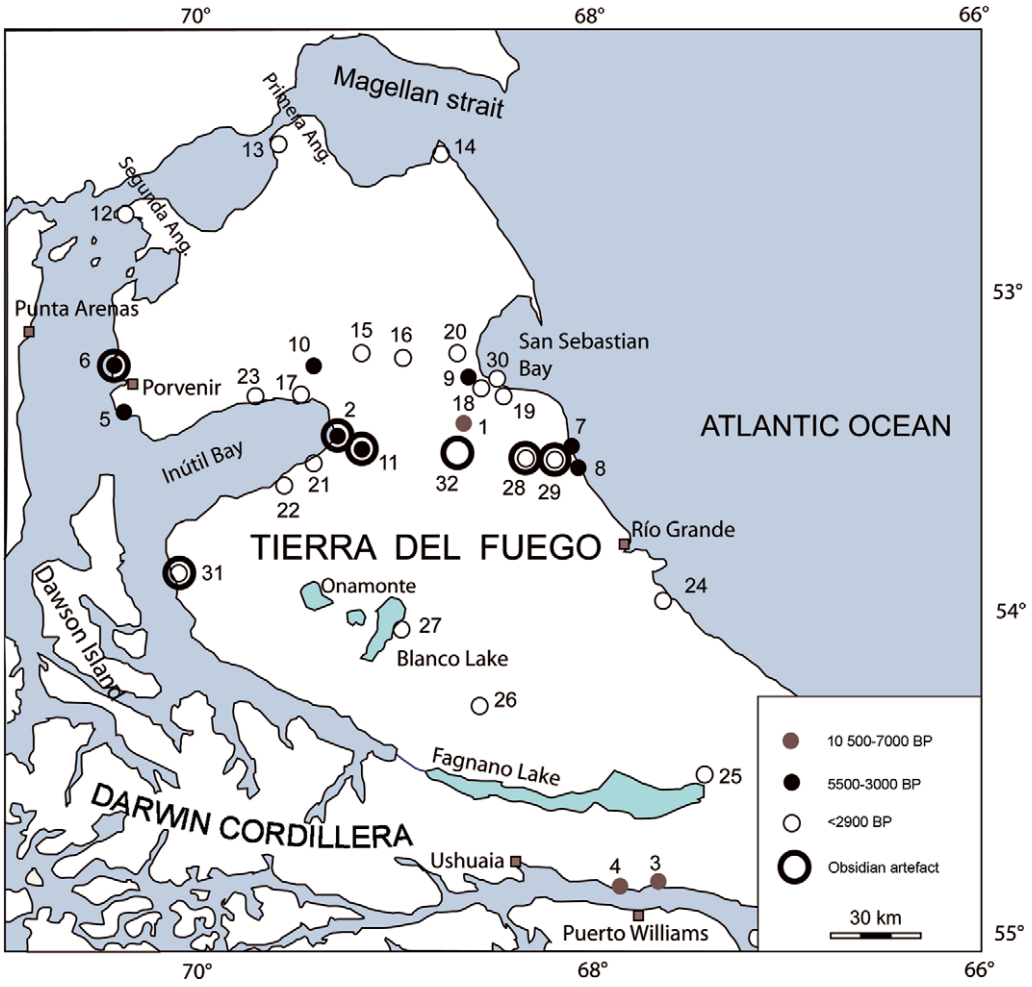


*Figure 1. Isla Grande de Tierra del Fuego with Holocene archaeological sites and location of obsidian artefacts: 1) Tres Arroyos 1, 7 and 14/ Cerro de los Onas; 2) Marazzi 1, 32 and 38; 3) Imiwaia 1; 4) Túnel 1; 5) Cabo Monmouth 20 and 5; 6) Porvenir Norte 12E, 17 and 19; 7) Laguna Arcillosa 1, 2 and 3; 8) Río Chico 1; 9) Cerro Las Bandurrias, Cerro 'Sin Nombre' and Cerro de los Gatos; 10) Myrén 2; 11) Marazzi 13; 12) Cabo San Vicente; 13) Punta Baxa 7; 14) Punta Catalina 3, 4 and Espíritu Santo 1; 15) Lago Vergara E23, E24; 16) Laguna Larga F1, F4; 17) Riachuelo Puesto Nuevo; 18) Cabeza de León/Bloque Errático; 19) San Genaro; 20) LA11 and LA12; 21) Marazzi 2-Río Torcido; 22) La Ballena 2, Taca Taca Sur, Bloque El Maucho and Bloque El Hediondo; 23) Bahía Inútil 27; 24) Punta María 2; 25) Fagnano 1; 26) Marina 1; 27) Lago Blanco 1; 28) Las Vueltas 1 and Laguna Grande; 29) Áviles 1, 3 and Amalia 4; 30) Puesto Pescador 1; 31) Río Caleta 4; 32) Puesto Consuelo.*

for water travel. Only the Aónikenk were recorded using makeshift rafts (made with tent sticks, branches and/or skins) to cross the Santa Cruz and Chico rivers (Fitzroy 1837: 119; Moreno 1969 [1879]: 242; Burucúa 1974: 54; Lista 1975: 42). Selk'nam escaping from the Salesian Mission on Dawson Island had to be helped by maritime hunter-gatherers to reach the main island of Tierra del Fuego by canoe (Chapman 2007).

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## Early environment and arrival of humans

Palaeoecological evidence suggests that the late glacial environment was predominantly open steppe and that the climate was significantly colder and drier than present. After *c.* 10 000 BP, southern beech woodland expanded into the region from the eastern flanks of the Darwin Cordillera (Markgraf 1993; McCulloch & Davies 2001) concomitant with a severe arid phase (*c.* 10 300–8200 BP) during which high charcoal presence suggests an increased frequency of fires. The region-wide nature of the arid phase suggests a climatic cause but the links between early people moving into the region and a higher fire frequency cannot be excluded. A more humid regime is recorded in pollen evidence after *c.* 8200 BP, as the Westerlies returned to their present position (McCulloch & Morello 2009). The pollen records from Dawson Island (McCulloch & Davies 2001) suggest that open southern beech woodland reached northern Tierra del Fuego by *c.* 9000 BP and expanded eastwards as far as Onamonte by *c.* 5130 BP (Heusser 1993).

The earliest human occupation of Tierra del Fuego is recorded at the Tres Arroyos 1 rockshelter (Figure 1, no.1), with hearth features dating to *c.* 10 500 BP (Massone *et al.* 1999a; Massone & Prieto 2004; Massone 2009). Human occupation was dated at 9590± 200 BP at the Marazzi 1 site (Figure 1, no. 2) (Laming-Emperaire *et al.* 1972), but can be questioned on the basis of a buried soil horizon dated to 8840±50 BP and bone dated to 4550±40 BP from the same stratigraphic units (Arroyo-Kalin 2009; Morello *et al.* 2009b). Thus, the earliest bona fide evidence for human occupation after Tres Arroyos 1 comes from the basal components of the Imiwaia 1 and Túnel 1 sites (Figure 1, nos. 3 & 4), which overlook the northern coast of the Beagle Channel. The assemblages at these sites, dated to 7840±50 BP and 6680±210 BP, are described as characteristic of terrestrial hunter-gatherers (Orquera & Piana 1999, 2009). However, lithic material is rare and some artefact types (rhomboidal lithic points, unifacial tranchets with a polished face and bevels) find no parallels in Fuego-Patagonia at any time range. Poorly preserved faunal remains suggest the consumption of guanaco and sea lion. It is difficult to infer direct relations between these and the Early Holocene occupation of Tres Arroyos 1. Instead, it is suggestive that these sites are located in an area where some of the earliest maritime hunter-gatherer evidence, south of the Strait of Magellan and dated to around 6400 BP, is recorded (Legoupil & Fontugne 1997; Orquera & Piana 1999).

## Mid Holocene development

The next signal of terrestrial hunter-gatherers in Tierra del Fuego is provided by occupations dated between 5500 and 3000 BP (Table 1), both on its north-western (Laming-Emperaire *et al.* 1972; Morello *et al.* 1999, 2009b) and Atlantic coasts: Laguna Arcillosa (Figure 1, no. 7; Salemme & Bujalesky 2000; Salemme *et al.* 2007) and Cerro Las Bandurrias (Figure 1, no. 9; Favier Dubois & Borrero 2005). Sites typically record the superposition of numerous discrete occupations in thin shell middens (mainly *Mytilus edulis*) with mixed terrestrial and maritime fauna. A range of lithic artefacts, mainly manufactured with local rocks, include mainly non-diagnostic artefacts such as side- and endscrapers, chopping tools, cores and flakes. Human burials associated with shell midden lenses are found in both

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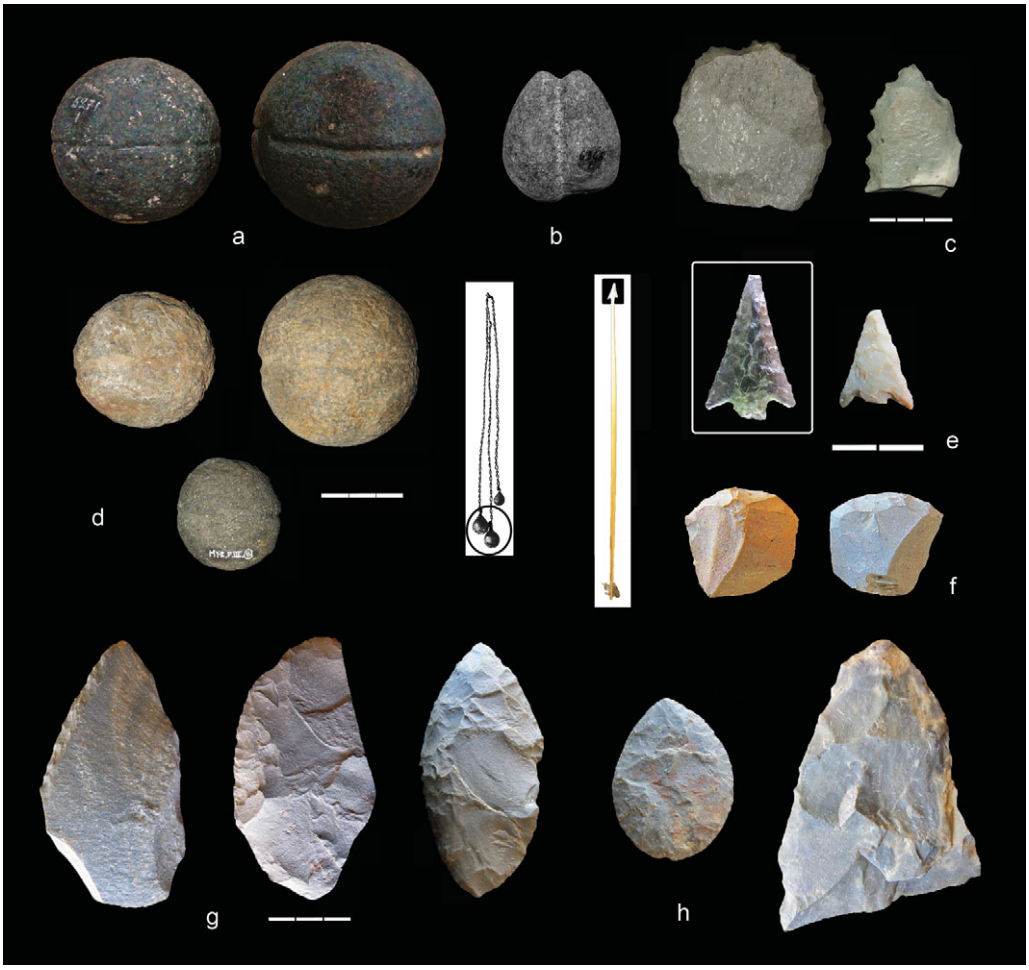


*Figure 2. Lithic artefacts: a) spheroid* bolas *from Marazzi 1, Middle Holocene levels; b) ovoid* bola *from the same site level; c) denticulate scrapers from Myrén 2; d) spheroid* bolas *also from Myrén 2; e) ethnographic arrow, glass projectile point, Ona type and Tres Arroyos 1 Ona type projectile point (silex rock); f) two small endscrapers from Tres Arroyos 1, Late Holocene levels; g) sidescrapers from Marazzi 1, Middle Holocene levels; h) bifacial artefacts from Marazzi 1, Middle Holocene levels.*

Laguna Arcillosa 2 and Marazzi 1, the latter showing partial cremation (Laming-Emperaire *et al.* 1972; Guichón 1992; Salemme *et al.* 2007). Faunal assemblages point to generalised diets based on guanaco consumption, supplemented, perhaps on a seasonal basis, by a diverse array of predictable marine resources. Further inland, the site of Myrén 2 (Figure 1, no. 10), located some 20km north of Inútil Bay, provides evidence of lithic and guanaco remains preserved in waterlogged peat associated with a small freshwater spring. Lithic materials include a small assemblage with uncommon denticulate scrapers and other objects such as the grooved spherical *bolas* (Figure 2), endscrapers and cores. Three radiocarbon dates suggest occupation events took place around 3900 BP (Massone *et al.* 1999b; Prieto *et al.* 2007). Marazzi 13 (Figure 1, no. 11), a rockshelter formed by a large erratic boulder

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*Figure 3. Marazzi 13 site at Bloque de la Obsidiana: general view.*

some 8km from the coast, shows a hearth with a small lithic assemblage that includes some obsidian (Figures 3 & 4, and see below) (Morello *et al.* 2009b).

## The last two millennia

The large number of archaeological sites dating to the last two millennia suggests significant demographic growth during this period. Redundancy and reoccupation in the use of sites is common, and all the available environments of the island appear to be occupied. This record suggests that effective occupation of space (*sensu* Borrero 1989–90) had been achieved. Archaeological projectile point types from this period can be linked to arrowheads recorded ethnographically—in stone and, during the twentieth century, in glass—among Selk'nam terrestrial hunter-gatherers (Figure 2).

In the interior steppe zone, various rockshelters and an open-air occupation in Cerro de los Onas (Figure 1, no. 1), where the Tres Arroyos 1 early site is located, date between 1500 and 700 BP. Remains include glass endscrapers, beads and debris, as well as metal remains

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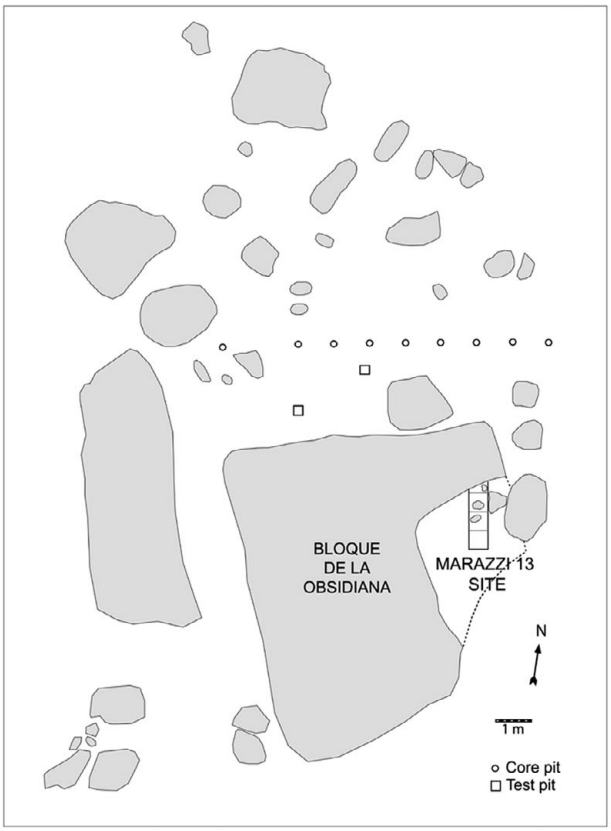


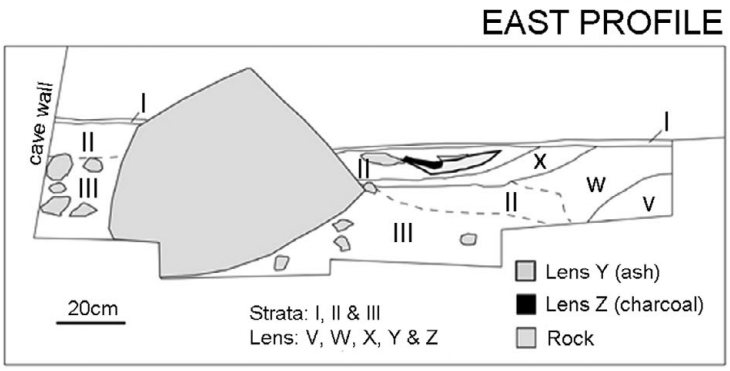


*Figure 4. Marazzi 13, plan and profile.*

and sheep bone (Massone *et al.* 1993). Other sites of similar age are found neighbouring saltwater lakes, such as Vergara (Figure 1, no. 15) and Larga (Figure 1, no. 16), and along San Sebastian Bay. In general, faunal assemblages at these sites are dominated by guanaco bones and the lithic toolkit is typical of terrestrial hunter-gatherers.

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**Table 1. Radiocarbon age information for Tierra del Fuego archaeological sites.**

| Site | $^{14}$C years BP | Dated material | Reference |
|---|---|---|---|
| **Pleistocene–Holocene transition** | | | |
| Tres Arroyos 1 | 10 855±70<br>10 130±210 | charcoal | Massone & Prieto 2004; Massone 2009 |
| **Early Holocene** | | | |
| Marazzi 1 | 9590±200 | charcoal | Laming-Emperaire *et al.* 1972; |
| | 8840±50 | sediment (palaeosoil) | Morello *et al.* 2009b |
| | 4550±40 | bone (indet.) | This paper |
| Imiwaia 1 | 7840 ±50 | charcoal | Orquera & Piana 2009 |
| Túnel 1 | 6980±110 | charcoal | Piana 1984; Piana & Orquera 2009 |
| | 6680±210 | charcoal | |
| **Middle Holocene** | | | |
| ***Coast*** | | | |
| Marazzi 1 | 6170±50 | shell (*Mytilus* sp.) | This paper |
| | 5570±400 | charcoal | Laming-Emperaire *et al.* 1972 |
| | 5440±30 | bone (*Lama guanicoe*) | Morello *et al.* 1999 |
| Cabo Monmouth 20 | 5520±50 | shell (*Mytilus* sp.) | Morello *et al.* 2009a |
| Laguna Arcillosa 1 | 5410±70 | shell (*Mytilus* sp.) | Salemme & Bujalesky 2000; Salemme *et al.* 2007 |
| Laguna Arcillosa 2 | 5508±48 | shell (*Mytilus* sp.) | Salemme & Bujalesky 2000; Salemme *et al.* 2007 |
| | 5205±58 | bone (*Homo sapiens*) | |
| | 4440±60 | shell (*Mytilus* sp.) | |
| | 3690±70 | shell (*Mytilus* sp.) | |
| Laguna Arcillosa 3 | 5353±53 | shell (*Mytilus* sp.) | Salemme & Bujalesky 2000; Salemme *et al.* 2007 |
| Río Chico 1 | 5856±44 | shell (*Mytilus* sp.) | Salemme & Bujalesky 2000; Salemme *et al.* 2007 |
| Cerro Las Bandurrias | 5700±180 | shell (*Mytilus* sp.) | Favier Dubois & Borrero 2005 |
| Porvenir Norte 12E | 3850±70 | shell (*Mytilus* sp.) | Morello *et al.* 2009b |
| ***Interior*** | | | |
| Myrén 2 | 4020±35 | bone (*Lama guanicoe*) | Massone *et al.* 1999b; Prieto *et al.* 2007 |
| | 3910±70 | bone (*Lama guanicoe*) | |
| | 3820±35 | bone (*Lama guanicoe*) | |
| Marazzi 13 | 3930±40 | charcoal (hearth) | Morello *et al.* 2009b |
| **Late Holocene** | | | |
| ***Coast*** | | | |
| Punta Baxa 7 | 1820±40 | charcoal (feature) | Morello *et al.* 2005 |
| | 1360±40 | bone (*Lama guanicoe*) | |
| | 1210±40 | bone (*Lama guanicoe*) | |
| Punta Catalina 3 | 2340±40 | charcoal (hearth) | Massone & Torres 2004 |
| | 2380±40 | charcoal (hearth) | |

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**Table 1. Continued**

| Site | $^{14}$C years BP | Dated material | Reference |
|---|---|---|---|
| Punta Catalina 4 | 1470±40 | indet. | Massone & Morello 2007 |
| Espíritu Santo 1 | 960±80 | bone (*Lama guanicoe*). | Horwitz 2004 |
| Cabo San Vicente I | 2135±30 | bone (*Lama guanicoe*) | Morello *et al.* 2009b |
| | 805±40 | charcoal | Massone & Morello 2007 |
| Porvenir Norte 17 | 2850±60 | shell (*Mytilus* sp.) | Morello *et al.* 2009b |
| Porvenir Norte 19 | 710±30 | bone (*Lama guanicoe*) | Morello *et al.* 2009b |
| Cabo Monmouth 20 | 2410±35 | bone (*Lama guanicoe*) | Morello *et al.* 2009a |
| Cabo Monmouth 5 | 1460±40 | shell (*Mytilus* sp.) | Morello *et al.* 2009b |
| Bahía Inútil 27 | 1600±50 | shell (*Mytilus* sp.) | Morello *et al.* 2009b |
| Marazzi 2 | 2745±40 | charcoal | Morello *et al.* 1998; Massone & Morello 2007 |
| | 1965±40 | bone (*Lama guanicoe*) | |
| | 910±70 | bone (*Lama guanicoe*) | |
| Marazzi 32 | 635±35 | charcoal (feature) | Massone & Morello 2007 |
| | 560±35 | charcoal (feature) | |
| Marazzi 38 | 795±35 | charcoal (feature) | Massone & Morello 2007 |
| | 785±35 | charcoal (feature) | |
| La Ballena 2 | 740±35 | bone (*Lama guanicoe*) | Morello *et al.* 2009b |
| Taca Taca Sur | 2970±130 | bone (*Lama guanicoe*) | Morello *et al.* 2009b |
| Bloque El Maucho (BIS41) | 935±35 | bone (*Lama guanicoe*) | Morello *et al.* 2009b |
| Bloque El Hediondo (BIS46) | 1470±35 | bone (*Lama guanicoe*) | Morello *et al.* 2009b |
| Cabeza de León 1–4 | 1100±95 | charcoal (hearth) | Borrero 1979; Martin & Borella 1999 |
| Bloque Errático 1 | 785±120 | bone (*Lama guanicoe*) | Borrero & Casiraghi 1980 |
| Puesto Pescador 1 | 335±35 | bone (*Homo sapiens sapiens*) | Suby *et al.* 2008 |
| San Genaro 1 | 610±45 | bone (*Lama guanicoe*) | Horowitz 1995, 2004 |
| | 1070±80 | charcoal | |
| | 1190±90 | shell (*Mytilus* sp.) | |
| | 1479±95 | shell (*Mytilus* sp.) | |
| | 1620±140 | shell (*Patinigera* sp.) | |
| San Genaro 2 | 380±70 | bone (*Lama guanicoe*) | Horwitz 1995, 2004 |
| | 440±70 | bone (*Lama guanicoe*) | |
| | 1483±80 | shell (*Mytilus* sp.) | |
| San Genaro 3 | 600±90 | shell (*Mytilus* sp.) | Favier Dubois 2001 |
| San Genaro 4 | modern | bone (Homo sapiens sapiens) | Martin *et al.* 2004 |
| Cerro 'Sin Nombre' | 1250±60 | bone (*Lama guanicoe*) | Favier Dubois & Borrero 2005 |
| Cerro de los Gatos | 900±115 | gastropods | Favier Dubois & Borrero 2005 |
| Punta Maria 2 | 300±100 | charcoal (hearth) | Borrero 1986 |
| | 720±50 | bone (*Lama guanicoe*) | |

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**Table 1. Continued**

| Site | $^{14}$C years BP | Dated material | Reference |
|---|---|---|---|
| | 1230±50 | bone (*Lama guanicoe*) | |
| | 2300±90 | bone (whale) | |
| | 2720±340 | charcoal (hearth) | |
| ***Interior*** | | | |
| Tres Arroyos 1 | 1340±50 | charcoal (feature) | Massone *et al.* 1993 |
| | 700±70 | charcoal (feature) | |
| Tres Arroyos 14(89) | 280±70 | charcoal (feature) | Massone *et al.* 1993 |
| | 210±50 | charcoal (feature) | |
| Tres Arroyos 14(30) | 2280±60 | bone (*Lama guanicoe*) | Prieto *et al.* 1997 |
| Tres Arroyos 7 | 100 ±50 | indet. | Massone *et al.* 1993 |
| Laguna Larga F1 | 1410±100 | bone (*Lama guanicoe*) | This paper |
| Laguna Larga F4 | 285±35 | bone (*Lama guanicoe*) | This paper |
| Lago Vergara E23 | 2560±140 | bone (*Lama guanicoe*) | This paper |
| Lago Vergara E24 | 360±30 | bone (*Lama guanicoe*) | This paper |
| Lago Vergara J24 | 855±35 | bone (*Lama guanicoe*) | This paper |
| La12 | 310±60 | bone (*Lama guanicoe*) | Massone *et al.* 1993 |
| Riachuelo Puesto Nuevo J17 | 1210±30 | bone (*Lama guanicoe*) | This paper |
| Avilés 1 | 1609 ±38 | bone (*Lama guanicoe*) | Santiago & Oría 2007 |
| Las Vueltas 1 | 949±41 | bone (*Lama guanicoe*) | Santiago & Salemme 2009 |
| ***Forest*** | | | |
| Fagnano 1, Locus 2 | 950±50 | bone | Ramos & Merenzon 2002–2004 |
| Marina 1 | 1800±250 | charcoal (hearth) | Mansur *et al.* 2000 |
| | 900±170 | charcoal (hearth) | |
| Lago Blanco 1 | 3180±40 | charcoal (hearth) | This paper |

The coastal zone is rich in archaeological remains but only a few occupations have been precisely dated. At Primera Angostura, lithic, bone remains and shell layers are distributed almost continuously over several kilometres. Within this complex, occupation has been dated to between 1800 and 1200 BP at Punta Baxa 7 (Figure 1, no. 13) (Morello 2000; Morello *et al.* 2005) and to *c.* 2300 BP at Punta Catalina 3 (Figure 1, no. 14). The latter is a shell midden with abundant land and marine faunal remains, along with large quantities of fish bones and fishing net weights made of stone (Massone & Torres 2004). Further to the south, other sites are recorded in the vicinity of Inútil Bay. These include Marazzi 2 (Figure 1, no. 21) (2745–970 BP), Marazzi 32 and 38 (Figure 1, no. 2), with dates *c.* 700 and 600 BP (Morello *et al.* 1998, 2004; Massone & Morello 2007), sites in erratic boulders (rockshelters in Bloque El Maucho-BIS41 and Bloque El Hediondo-BIS46, Figure 1, no. 22) and open-air sites (La Ballena 2 and Taca Taca Sur, Figure 1, no. 22; see Table 1).

On the Atlantic coast, a number of small tertiary outcrops and erratic boulders record Late Holocene occupations: Cerro 'Sin Nombre', Cerro de los Gatos, Cabeza de León, Bloque Errático 1 (Figure 1, nos. 9 & 18; Table 1). At San Genaro, near San Sebastián

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Bay (Figure 1, no. 19), dates start around 1600 BP and reach early modern times (Borrazzo 2004). Further to the south, Punta María 2 (Figure 1, no. 24) records a sequence of repeated occupations focused on the acquisition of marine resources from *c*. 3000–300 BP (Borrero 1986).

It is important to point out that the high density of sites in some parts of Tierra del Fuego could partly reflect the intensity of archaeological research since the early 1960s (e.g. Laming-Emperaire 1972a & b; Laming-Emperaire *et al.* 1972; Massone 1997, 2004; Massone *et al.* 2003; Borrero & Barberena 2004). The intensity of research in the central-southern part of the island, which is dominated by mountains and forests, is much lower and thus site densities are not comparable. However, a date of 3180 BP at Lago Blanco 1 (Figure 1, no. 27) (this paper) provides evidence for occupation in the 5000–3000 BP time range. Occupations at Marina 1 (Figure 1, no. 26) (Mansur *et al.* 2000) are dated between 1800 and 900 BP. Strong ethnographic evidence exists of Selk'nam occupations in Lago Fagnano (Chapman 2007).

## Interaction

Discussion about interaction, contact and mobility in pre-Columbian Fuego-Patagonia has focused on diagnostic artefacts, especially projectile points and *bolas* (Figure 2) (Laming-Emperaire 1972a & b; Bird 1993). More recently, decorated bone instruments and the mobile art of canoe groups have also been discussed (Fiore 2006). However, it is difficult to employ this type of evidence to discuss interaction patterns of terrestrial groups because all Fuego-Patagonia assemblages share a common cultural baggage that is punctuated by roughly synchronic changes over time. Clear diagnostic types emerge only during the Late Holocene, mainly the small, stemmed projectile points (arrowheads) known as the Ona type.

More useful indicators of interaction are finds of obsidian artefacts at terrestrial hunter-gatherer sites (see Figure 1). At Marazzi 13, also known as 'Bloque de la Obsidiana' (Figure 1, no. 11), a small number of flakes (n=12) are of black and green obsidian. The lithic remains are associated with an ashy lens (small hearth feature, Figure 4) dated to *c*. 3930 BP (Morello *et al.* 2009b). Apart from a 45mm-long green obsidian flake, all lithic pieces are small (<30mm). Seven black obsidian pieces are mainly internal flakes or fragments, one split debris, and another is a flake fragment with some remaining cortex. The assemblage suggests a curation strategy.

Recent studies show that Patagonian black obsidian comes from a unique source some 600km north of the Strait of Magellan, at the Pampa del Asador (PDA) (Figure 5). Its presence, widespread throughout Patagonia, is restricted to Holocene age terrestrial hunter-gatherers. In the quarry three chemical types have been identified, with four to six sub-types (Stern 2000, 2004). Two archaeological samples of black obsidian from the Marazzi 13 site were analysed using bulk laser ablation ICP-MS analysis and results correspond to two different chemical sub-types from Pampa del Asador: PDA1 and PDA2 (Table 2; Figure 6). Green obsidian also has a unique source, located in an unknown location near the Otway Sea and Riesco Island.

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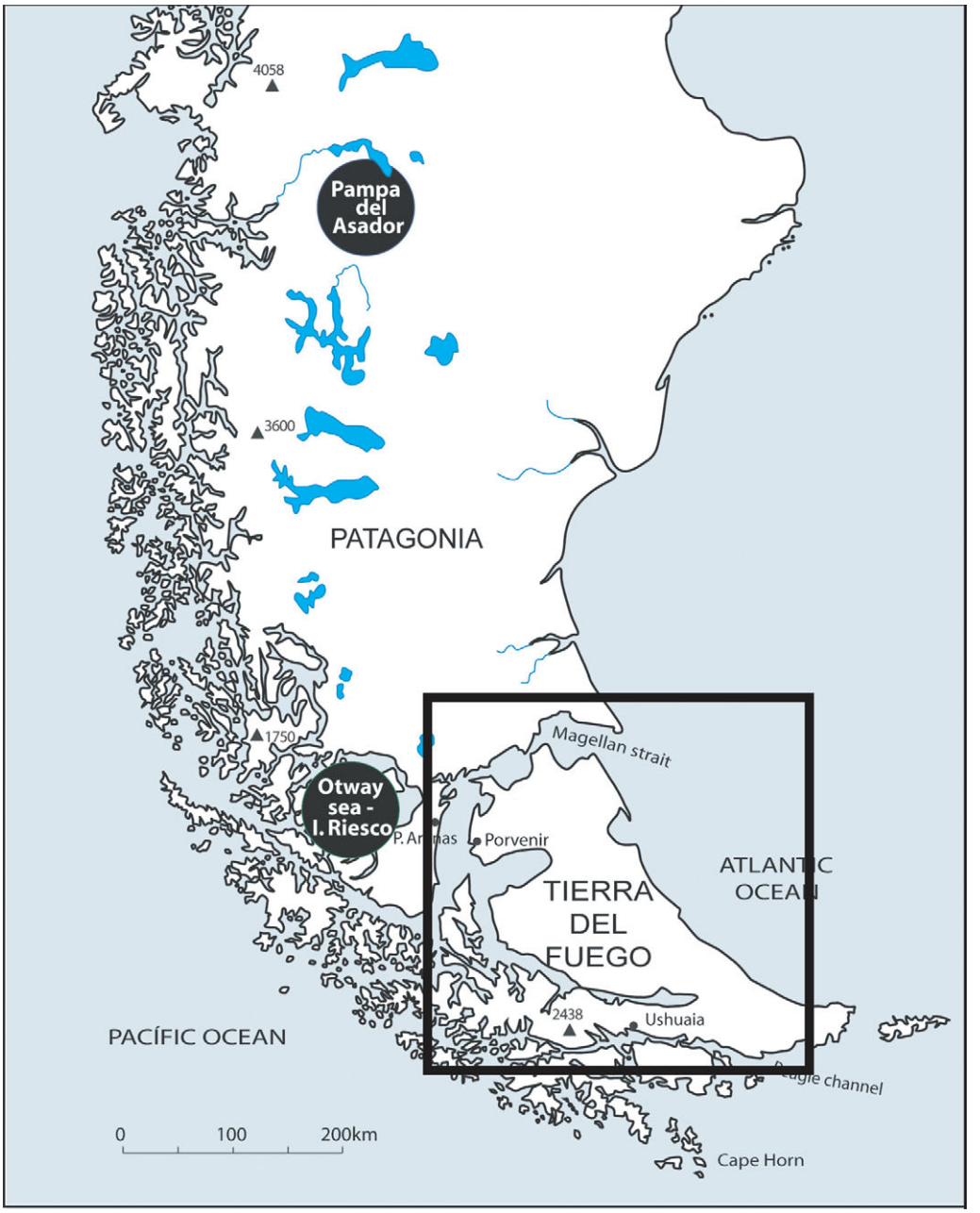


*Figure 5. Obsidian sources in Patagonia.*

Other variability is suggestive: while in mainland Patagonia *boleadoras* remained in use until the twentieth century and *bolas* are found in archaeological assemblages from early on, in Tierra del Fuego *bolas* disappear from terrestrial hunter-gatherer sites around 1500 BP,

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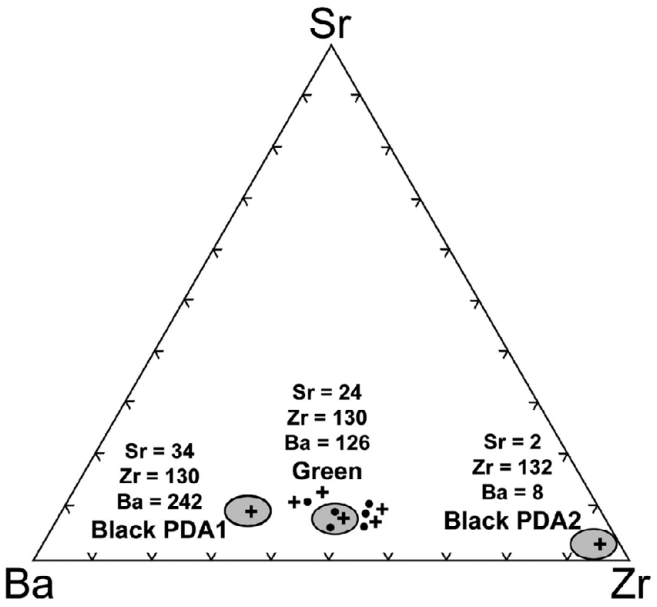


*Figure 6. Chemical composition ranges of green and black obsidian (shaded fields) determined by bulk XRF and ICP-MS analysis of larger samples. Smaller samples analysed by laser ablation ICP-MS techniques are indicated by plus signs (+) for obsidian artefacts from Tierra del Fuego, and solid dots for artefacts from other locations (Table 2).*

implying abandonment of the technology. Ethnographic records do not mention their use among the Selk'nam (Torres 2009).

## Discussion and conclusion

As a result of recent investigations we now understand something of the development of human occupation in Tierra del Fuego from *c.* 10 500 years ago to the indigenous Selk'nam society observed over the last few hundred years. A gap exists between early (*c.* 10 500 BP) and Middle Holocene (*c.* 5000 BP) occupations, and a series of hypotheses have been advanced to explain it, including local extinction or out-migration of early late-glacial groups (Borrero 1996; Borrero & McEwan 1997). In theory, harsh environmental conditions and natural barriers forming at *c.* 8000 BP could have caused independent and discontinuous development. However, the arrival at *c.* 6500 BP of maritime groups distinct from Fuego-Patagonian terrestrial hunter-gatherers (Legoupil & Fontugne 1997; Alvarez 2004; Fiore 2006; Piana & Orquera 2009) may have partially transformed biogeographic barriers into a 'water bridge' (Fiore 2006). Over two time periods—an initial strong pulse between *c.* 5000 and 3000 BP and another within the last 1000 years—the central portion of the Strait of Magellan may have become a crucial route for intergroup exchange, minimally leading to circulation of raw material (obsidian) and an intangible flow of ideas and artefact morphology. Thus, archaeological evidence makes it increasingly clear that canoe peoples

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**Table 2. Trace-element compositions of obsidian samples from Tierra del Fuego (TDF) and rock sources.**

| | Site | Sr | Zr | Ba |
|---|---|---|---|---|
| **Green obsidian from TDF** | | | | |
| AGOB-5 | Marazzi 13 | 20 | 80 | 101 |
| AGOB-8 | Marazzi 1 | 8 | 53 | 36 |
| AGOB-6 | Marazzi 22 | 19 | 79 | 75 |
| AGOB-9 | Porvenir Norte 28 | 11 | 71 | 51 |
| CS4 | Río Caleta 4 | 11 | 79 | 71 |
| **Green obsidian from elsewhere** | | | | |
| AGOB-7 | Cabo León | 11 | 66 | 48 |
| AGOB-4 | Río Batchelor | 16 | 65 | 78 |
| AGOB-3 | Río Batchelor | 11 | 67 | 45 |
| AGOB-1 | Tilland 1 | 10 | 59 | 51 |
| Green1 | Seno Otway | 14 | 81 | 74 |
| Green2 | Seno Otway | 12 | 90 | 72 |
| **Black obsidian from TDF** | | | | |
| CS7 (identified as type PDA1) | Marazzi 13 | 29 | 108 | 192 |
| MM1 (identified as type PDA2) | Marazzi 13 | 2 | 127 | 6 |
| **Black obsidian from elsewhere** | | | | |
| CS-PDA1 | Pampa del Asador | 26 | 104 | 220 |
| CS-PDA2 | Pampa del Asador | 1 | 103 | 6 |
| CS951 (green) | Puesto Consuelo 3 | 24 | 155 | 105 |
| Green bulk | Seno Otway | 24 | 130 | 126 |
| PDA1 bulk | Pampa del Asador | 34 | 130 | 242 |
| PDA2 bulk | Pampa del Asador | 2 | 132 | 8 |

Lasar-ablation Sr, Ba and Zr data and bulk ICP-MS analysis in parts per million (ppm).

helped to mitigate the effects of insularisation on Tierra del Fuego's terrestrial hunter-gatherers during the second half of the Holocene.

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