Investigate the Shore, Sound out the Past: Methods and Practices of Maritime Prehistory
Explorer la côte, sonder le passé : méthodes et pratiques de la préhistoire maritime
Actes de la séance de la Société préhistorique française de Brest (décembre 2020)
Textes publiés sous la direction de Grégor Marchand (†), Yvan Pailler et Pierre Stéphan
Paris, Société préhistorique française, 2023
(Séances de la Société préhistorique française, 19), p. 61-90
www.prehistoire.org
ISSN : 2263-3847 – ISBN : 978-2-913745-92-6

Geoarcheology and Prehistory of the St. Pierre and Miquelon Archipelago: Theoretical Issues, Methods and Preliminary Results

Géoarchéologie et préhistoire de l'archipel de Saint-Pierre-et-Miquelon : problèmes théoriques, méthodes et résultats préliminaires

Grégor Marchand, Réginald Auger, Cédric Borthaire, Mikaël Guiavarc'h, Maureen Le Doaré, Lolita Rousseau, Pierre Stéphan

---

Abstract: The French overseas territory of St. Pierre and Miquelon comprises three main islands and is located approximately 20 km south of the island of Newfoundland (Canada). As part of a Unesco project to classify maritime heritage, a Franco-Canadian team has begun excavating the coastal site of Anse-à-Henry, which was occupied from the Maritime Archaic time to the historical period. Integrating multiple scales of analysis, the scientific approach adopted is more global than just a simple excavation. It includes a geomorphological component (monitoring erosion, changes in sea levels) and an archaeological component (inventory of the heritage, dating of the various occupations, reconstruction of occupation networks). The project began in 2018 with a systematic survey of archaeological anomalies using LiDAR data, which led to the identification of 43 areas with high potential for habitat remains. Analyses of the shoreline morphologies of Anse-à-Henry reveal that different sectors of coastline have been affected either by marine erosion processes (wave action) or by subaerial processes such as runoff, colluviation, etc. The 2019 and 2021 excavations uncovered extremely well-preserved Groswater occupations in the low-lying area of the site and demonstrated the extent of the site area; a substantial addition to what was excavated in the early 2000s. The Middle Dorset and First Nations occupations (Recent Tradition) have also left abundant remains, but more scattered over the 3.6 ha site. Surveys throughout the archipelago led to the discovery of five quarries, including the Bois Brûlé quarry in St. Pierre exploited for its rhyolite deposits. Results of the geochemical analyses conducted on the Bois Brûlé samples link some of these quarries to objects collected at Anse-à-Henry.
Keywords: Dorset, Groswater, rhyolite, St Pierre and Miquelon, Recent Period.

Résumé : Territoire français d'outre-mer, l'archipel de Saint-Pierre-et-Miquelon comprend trois îles principales, situées à une vingtaine de kilomètres au sud de l'île de Terre-Neuve (Canada). Dans le cadre d'un projet de classement de patrimoine maritime par l'Unesco, une équipe franco-canadienne a entamé la fouille du site côtier de l'Anse-à-Henry, occupé de la période Archaïque maritime à la période historique. La démarche scientifique empruntée est plus globale qu'une simple fouille, avec l'intégration de multiples échelles d'analyse. Elle comprend un volet géomorphologique (suivi de l'érosion, changement des niveaux marins) et un volet archéologique (inventaire du patrimoine, datation des différentes occupations, restitution des réseaux d'occupation). Le programme a débuté en 2018 par le relevé systématique des anomalies archéologiques à l'aide de données LiDAR, ce qui a mené à l'identification de 43 zones à fort potentiel de vestiges d'habitat. L'analyse des morphologies rencontrées à l'Anse-à-Henry, le long du rivage, a permis de distinguer différentes portions de côte affectées soit par les processus d'érosion marine (action des vagues) soit par les processus subaériens (ruissellement, colluvionnement, etc.). Les nouvelles fouilles ont permis de détecter des occupations Groswater très bien préservées dans la zone basse du site, tout en montrant l'ampleur des remaniements post-dépositionnels dans la zone principale, fouillée dans les années 2000. Les occupations du Dorset moyen et des Premières Nations (période qualifiée aussi de « Tradition récente ») ont également laissé des vestiges abondants, mais davantage dispersés sur les 3,6 ha du site. Les prospections pédestres menées dans tout l'archipel ont conduit à la découverte de cinq carrières, dont celle de Bois brûlé, à Saint-Pierre, destinée à l'exploitation de la rhyolite. Des analyses géochimiques ont été menées sur ces roches ; elles permettent d'ores et déjà de lier certaines des carrières à des objets lithiques recueillis à l'Anse-à-Henry.

Mots-clés : Dorset, Groswater, Paléo-Inuit, rhyolite, Saint-Pierre-et-Miquelon, Tradition récente.

1. QUESTIONS POSED ON THE ARCHAEOLOGICAL HERITAGE OF ST PIERRE AND MIQUELON

1.1. Cultural context: First Nations in Newfoundland

A brief cultural context is necessary to better understand the issues developed in the St. Pierre and Miquelon archipelago (fig. 1). The first occupations around the St. Lawrence River estuary are attributed to the Early Maritime Archaic, initially defined by J. A. Tuck (1971), around 7500 BCE (Betts and Hrynick, 2021). Their extension onto the island of Newfoundland is only identified during a recent phase (Late Maritime Archaic), in a cultural movement described as "Southern Branch" common to southern Labrador and northern Newfoundland (around the Strait of Belle Isle). There would be a gap of one millennium with the Labrador occupations, i.e. around 2600 BC (Renouf, 1999; Betts and Hrynick, 2021). Despite a scarcity of reliable archaeological data, the strong maritime tropism of these populations is underlined, as well as the existence of long-distance material acquisition networks (e.g. the Ramah chert, whose sources are more than 1,000 km from Newfoundland and notably the major archaeological sites of Port-aux-Choix).

The irruption of totally different populations from the Arctic Circle, previously described as "Paleo-Eskimo" and now as "Paleo-Inuit" or "Pre-Inuit", occurred during a marked cooling episode around 2100 BC. The first of these to reach the island of Newfoundland was the Groswater, initially defined by W. Fitzhugh (1972) on the basis of an eponymous site in Labrador. This phase is thought to date from 800 to 100 BC, at a time of marked climatic improvement. Bifacial points with lateral notches and a square base (box-base), burin-like tools, bipointed armatures, small wide-fronted scrapers and microblades are attributed to this group (Auger, 1984; Betts and Hrynick, 2021; Lavers and Renouf, 2012). The emergence of the Groswater represents a period of dramatic population growth and maximum expansion of this region. Sites from this phase are found throughout the region, from the northern part of Labrador to St. Pierre island (LeBlanc, 2008).

It was succeeded by the Dorset culture around 500 BCE in northern Labrador and a few centuries later in Newfoundland. This again appears to be a southward movement of populations and not an in situ evolution of the Pre-Dorset (Tuck and Fitzhugh, 1986; Renouf, 1993 and 1999). It is during the middle phase of its development, between 0 and 500 AD, that Dorset clearly asserts its presence (Renouf, 2003, 2005 and 2006). The endblades with a groove and concave base are particularly characteristic of the Middle Dorset (LeBlanc et al., 2001). In a comparative study of eight Middle Dorset sites (including Anse-à-Henry), S. LeBlanc (2008) proposed the hypothesis of a regionalism of Dorset culture in Newfoundland. This idea was first expressed in the work of U. Linnamae (1975) under the name of Typical Newfoundland Dorset. It would be expressed by triangular distal armatures with concave bifacial bases. While Groswater groups had a diet based on land and sea resources and moved strategically with the seasons to take advantage of the availability of small marine mammals, caribou and other small land mammals (LeBlanc, 2000), the Dorset groups appear to have been better adapted to the exploitation of marine resources (Renouf, 1999). The disappearance of this culture remains an enigma of archaeological research in the Atlantic Northeast (Betts and Hrynick, 2021), as well as at Port-aux-Choix in Newfoundland around 800 CE, four centuries before their decline in Labrador.

This was followed by a cultural group described as "Maritime Woodland" in the continental provinces around the St. Lawrence and "Boreal Woodland" in Newfoundland and Labrador (Betts and Hrynick, 2021). Once again, there is a sharp break with the technical traditions and lifestyles of the Paleo-Inuit groups. In Newfoundland, this culture would only appear around 200 BC (Late Boreal Woodland), which implies a coexistence of almost a millennium with the Dorset populations. Formerly called "Recent Indian" (LeBlanc et al., 2001; LeBlanc and Rabottin, 2000, 2003 and 2005; Betts and Hrynick, 2021), these cultures are now integrated into a "Recent Tradition" of the Early First Nations of Newfoundland. There are three successive phases on this large island: Cow Head, Beaches and Little Passage. The latter is directly linked to the Beothuk who were contemporary with the European arrival from the 16th century. The arrow fittings with stems are characteristic of these groups; this technical change is probably linked to modifications in terms of subsistence economy resulting in a decrease of the marine mammals hunting in favour of land mammals.

The prehistory of Newfoundland thus shows series of population breaks (Archaic/Groswater; Groswater/Dorset; Dorset/Recent Tradition). J. A. Tuck and R. T. Pastore (1985) linked them to the resources available, marked by successive extinctions of caribous and harp seals followed by repopulations from Labrador, a hypothesis challenged by M. A. P. Renouf (1999) who emphasised periods of cohabitation. Located at the southern tip of the island of

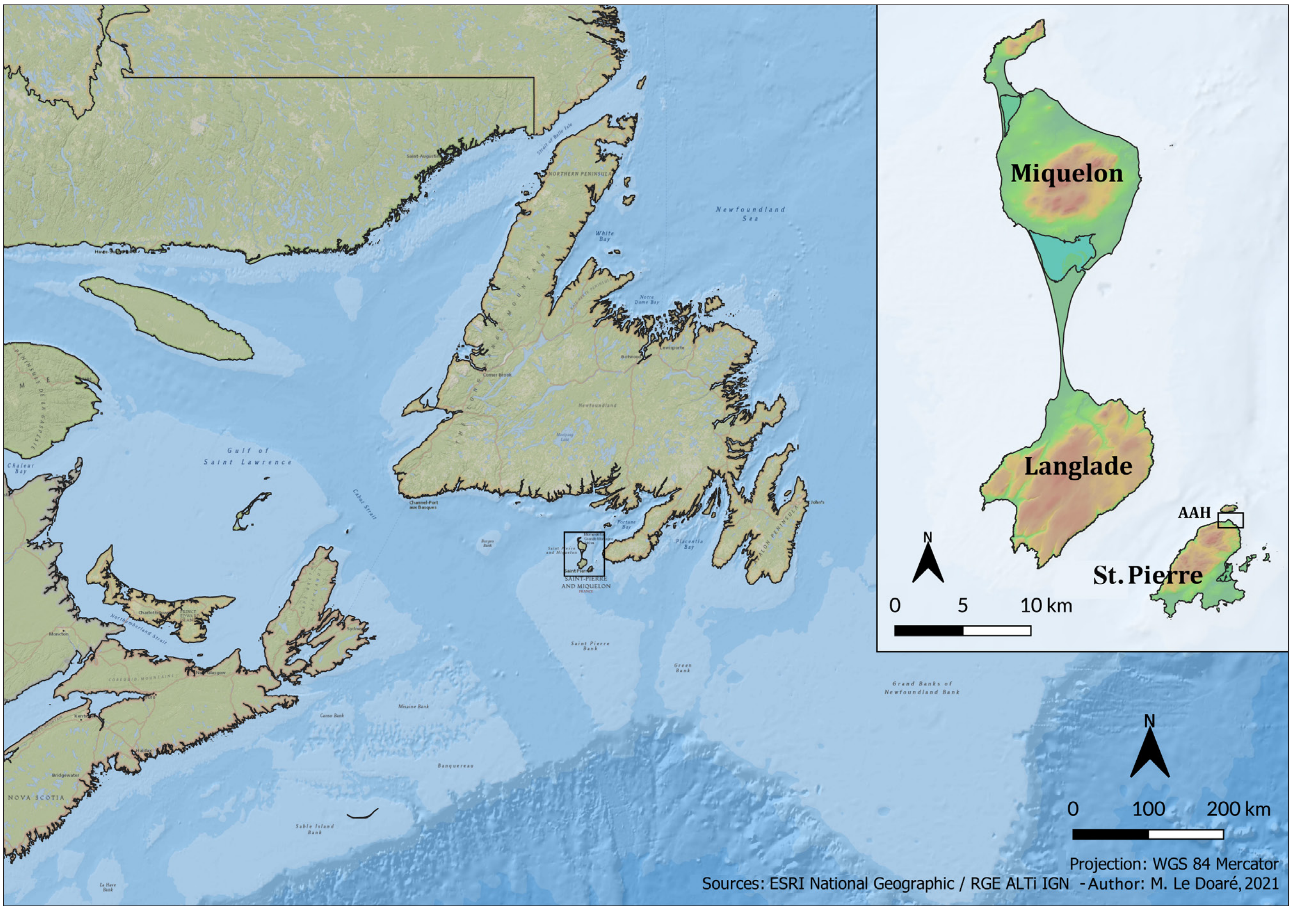


Fig. 1 – Location of the St. Pierre and Miquelon archipelago to the south of Newfoundland, Canada (map M. Le Doaré).
Fig. 1 *– Localisation de l'archipel de Saint-Pierre-et-Miquelon, au sud de Terre-Neuve, Canada (carte M. Le Doaré).*

Newfoundland, the St. Pierre and Miquelon archipelago has been part of this history, as evidenced by the remains collected from the 1980s until the recent operations discussed in this article.

1.2. Initial project scope

The French overseas territory of St. Pierre and Miquelon comprises three main islands and is located 20 km south of the island of Newfoundland (Canada; fig. 1). The recent archaeological work reported in this article is being carried out as part of a proposal to classify the St. Pierre and Miquelon archipelago as a Unesco World Heritage Site, with fishing activities as its corner stone. The first step in this long-term process, which combines heritage considerations and political orientations supporting economic development, was jointly initiated in 2017 by a local heritage group, the prefecture of St. Pierre and Miquelon and France's department of Culture. The temporal depth of the fisheries was an essential consideration when developing the classification proposal. This necessarily involved a new examination of the Anse-à-Henry site, located on the north tip of St. Pierre which already provided clues to the entire archaeological chronology of the region, from the Maritime Archaic to the ancestors of the Beothuk. Anse-à-Henry is also the southernmost Paleo-Inuit presence, first with the Groswater phase, which is identified in Newfoundland during the last millennium BCE, and then with the Dorset (Middle Dorset) that succeeded it until about 800 CE (Renouf, 1999; Betts and Hrynick, 2021). Understanding the cultural and technical organisation of these ancient cultures' exploitations of the halieutic resources is a challenge. There is also evidence of a European occupation in the upper part of the site, which remains to be characterised.

The Anse-à-Henry site was first identified by J. Chapelot during his fieldwork in the archipelago between 1979 and 1983 (Schmidt, 1983). While limited test pit excavations were conducted in the mid-1990s by J. A. Tuck, professor at Memorial University of Newfoundland at the time, a number of systematic studies were carried out in the early 2000s by S. LeBlanc in collaboration with J.-L. Rabottin, a geomorphologist from St. Pierre and Miquelon (LeBlanc and Rabottin, 2000, 2003 and 2005). That work provided an overview of the existing knowledge of this extensive site, whose surface area was estimated at approximately four hectares. The dwellings and activity areas that have been uncovered show evidence of frequent occupations, probably dating back as far as 3000 BCE. In addition, the Dorset component was the subject of a doctoral dissertation submitted to the University of Alberta by S. LeBlanc (2008). Because this unique site was being irremediably impacted by coastal erosion, R. Auger and G. Marchand were called upon in 2018 to rescue the site in order to finish documenting both the seasonal hunter-gatherer populations and the fishers of European origin, whose dwellings, workshops, fish processing structures (also called *grave* in French, not to be confused with the word "cemetery" in English!) and ceramics testify to their presence in the modern period (Marchand et al., 2020).

How can the diversity of the economic strategies of these Amerindian and Paleo-Inuit societies be fully evaluated? The exploitation of different parts of the maritime ecosystems was based on collective mobility practices, whether within the archipelago or around Newfoundland. The origin of the lithic materials is the readily available interpretative keys we have to establish an initial map of the exchange networks. The uniqueness of the Anse-à-Henry site in such a large archipelago was paradoxical; it points out to an important gap in our understanding. Limited prospections carried out in 2019 and 2020 have demonstrated the extant of the task of achieving an exhaustive knowledge of the territorial occupation networks prior to the European occupation. The development of an archaeological map under the aegis of France's ministry of Culture and the prefecture of St. Pierre and Miquelon should enable us to better manage the archipelago buried heritage.

For reasons of principle, it is no longer possible to ignore the erosive factors, which have an effect on the nature of the "archaeological record". In this period of accelerated global warming, erosion is particularly active both from the onslaught of waves that erode the shorelines, which freeze for ever shorter durations each winter, and from the intense movement of the colluvium that migrates down slopes. An understanding of the landscapes of the past and of the resources available at these different times is not possible without a thorough investigation of the geographical conditions, specifically, changes to sea levels. The St. Pierre and Miquelon archaeological project has therefore from the outset combined an examination both of the human remains and the conditions of geological deposits. The project has also provided an opportunity to incorporate various methodological approaches and schools of thought bringing together, for example, a dialogue with the First Nations, a concern in Canadian archaeology and the geoarchaeological approaches developed in French prehistory over the past half-century.

1.3. Integration of the scales of analysis

In order to work on and integrate the various geographical scales, our strategy comprises a number of objectives:

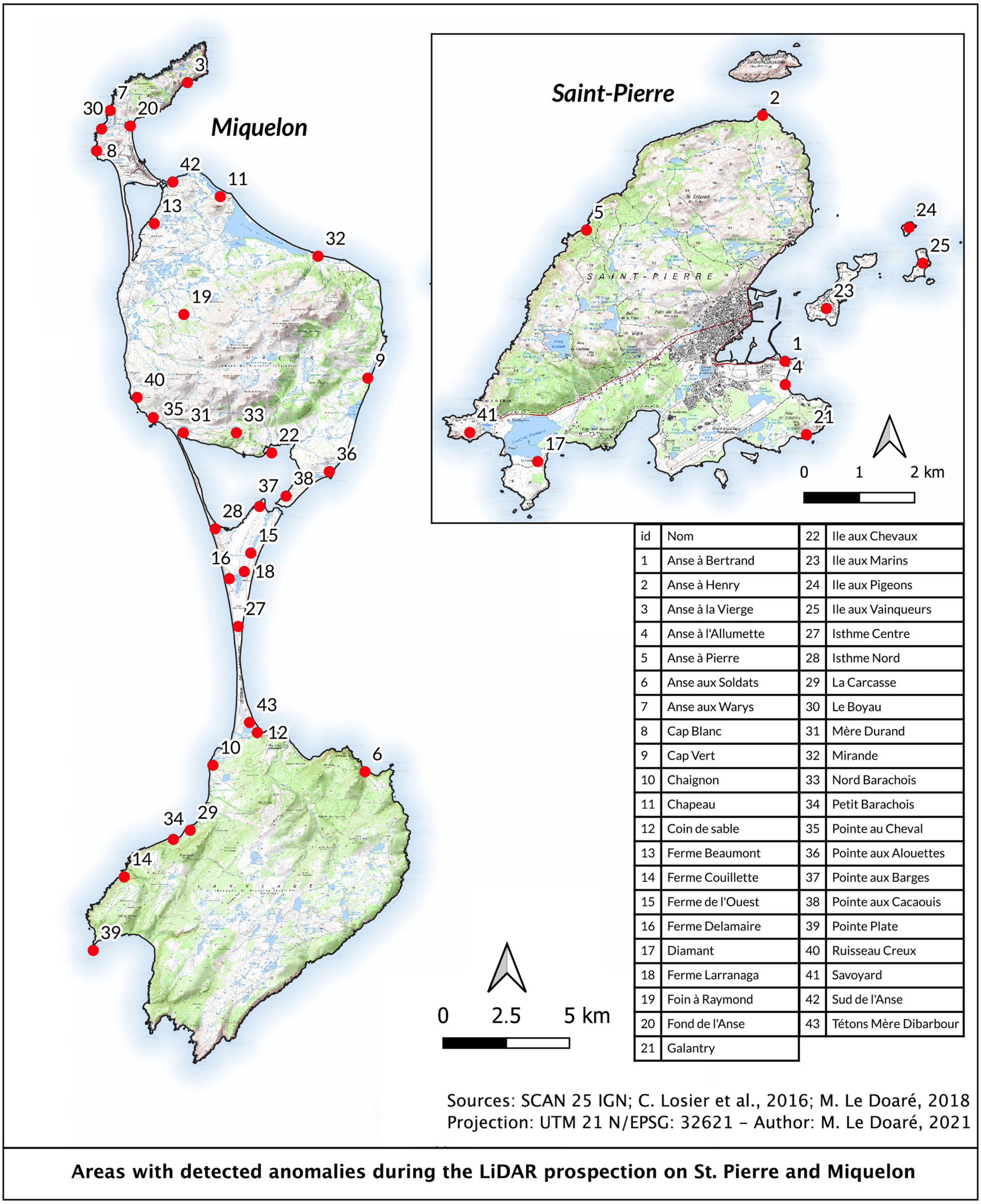
1. Systematic survey of archaeological anomalies using LiDAR data and analysis in connection with historical knowledge (leader: M. Le Doaré).
2. Integration of the archaeological programme into various institutions and communities in St. Pierre and Miquelon and Newfoundland (prefecture of St. Pierre and Miquelon; Service Régional de l'Archéologie de Bretagne; l'Arche Musée et Archives; Lycée Émile-Letournel; Mi'kmaw Community of Miawpukek in Newfoundland).
3. Establishment of a protocol for the monitoring of coastal erosion at Anse-à-Henry over three years (leader: P. Stéphan, with the active support of the direction des Territoires, de l'Alimentation et de la Mer).
4. Archaeological excavation and mapping of the Amerindian, Paleo-Inuit and European occupations at Anse-à-Henry (directors: R. Auger and G. Marchand, 2019-2023).
5. Extensive prospections in the archipelago (historical and prehistoric archaeology as well as petroarchaeology), begun in September 2019 and extended in August 2020.
6. Archival research to better understand the nature of the European and indigenous occupations of the territory.

2. A PRELIMINARY ANALYSIS OF THE LiDAR DATA ON THE ARCHIPELAGO

In 2018, a member of our team (M. L. D.) carried out a remote sensing study on the archipelago using LiDAR. Remote sensing makes it possible to study vast areas in a short time span. It allows to collect initial spatial information on the archipelago, whose surface area totals 242 km². The LiDAR survey results were compared to historical maps, texts and aerial photographs (current and old) to support our interpretations of the anomalies identified. The promising features, in addition to those found at Anse-à-Henry, were investigated during the 2019 season.

This first stage suggested the presence of 43 potential sites across the archipelago: 32 are on Miquelon, 10 on St. Pierre and its islands and one on l'Île Verte (Green Island; fig. 2). However, low and dense vegetation in many areas proved a major obstacle to the analysis and rendered the information collected worthless. The study focused on the coastline as this had been the most utilised space on the islands (for accessibility and resources reasons). Inland areas were explored less thoroughly due to a lack of time. Most of the sites that were identified dated from the historic period while prehistoric sites are difficult to identify in this environment using LiDAR since they present few or no surface features that can be detected. The small number of structures visible through LiDAR at the Anse-à-Henry site dated from the historic period (fig. 3). Finally, the reading was also disrupted by periglacial geometric elements, therefore, field verification of the anomalies detected during this first stage was necessary.

The archipelago has a troubled and violent history dating from its discovery by Europeans in 1520 to the signing of the Treaty of Paris in 1814, which declared that the archipelago belonged to France. Its shores were pillaged alternately by the French and the English numerous times over the intervening three centuries (Ribault, 1962; Lebailly, 2015). As a result, many of the former settlements were either destroyed or forgotten by the popula-



id	Nom	id	Nom
1	Anse à Bertrand	22	Ile aux Chevaux
2	Anse à Henry	23	Ile aux Marins
3	Anse à la Vierge	24	Ile aux Pigeons
4	Anse à l'Allumette	25	Ile aux Vainqueurs
5	Anse à Pierre	27	Isthme Centre
6	Anse aux Soldats	28	Isthme Nord
7	Anse aux Warys	29	La Carcasse
8	Cap Blanc	30	Le Boyau
9	Cap Vert	31	Mère Durand
10	Chaignon	32	Mirande
11	Chapeau	33	Nord Barachois
12	Coin de sable	34	Petit Barachois
13	Ferme Beaumont	35	Pointe au Cheval
14	Ferme Couillette	36	Pointe aux Alouettes
15	Ferme de l'Ouest	37	Pointe aux Barges
16	Ferme Delamaire	38	Pointe aux Cacaouis
17	Diamant	39	Pointe Plate
18	Ferme Larranaga	40	Ruisseau Creux
19	Foin à Raymond	41	Savoyard
20	Fond de l'Anse	42	Sud de l'Anse
21	Galantry	43	Tétons Mère Dibarbour

Fig. 2 – Sites with anomalies in the St. Pierre and Miquelon archipelago detected using LiDAR (analyses and maps M. Le Doaré).
Fig. 2 *– Sites de l'archipel de Saint-Pierre-et-Miquelon présentant des anomalies détectées à l'aide du LiDAR (analyses et cartes M. Le Doaré).*

tions, who were deported on several occasions. The historical occupation of the archipelago is therefore largely unknown, except through few maps and archives. The numerous presumed historical structures that have been uncovered during the present investigation will therefore contribute to expand our knowledge of the troubled history of the archipelago.

Pointe aux Cacaouis site illustrates such potential for remembering the past. Numerous topographical anomalies have been identified on the LiDAR and verified

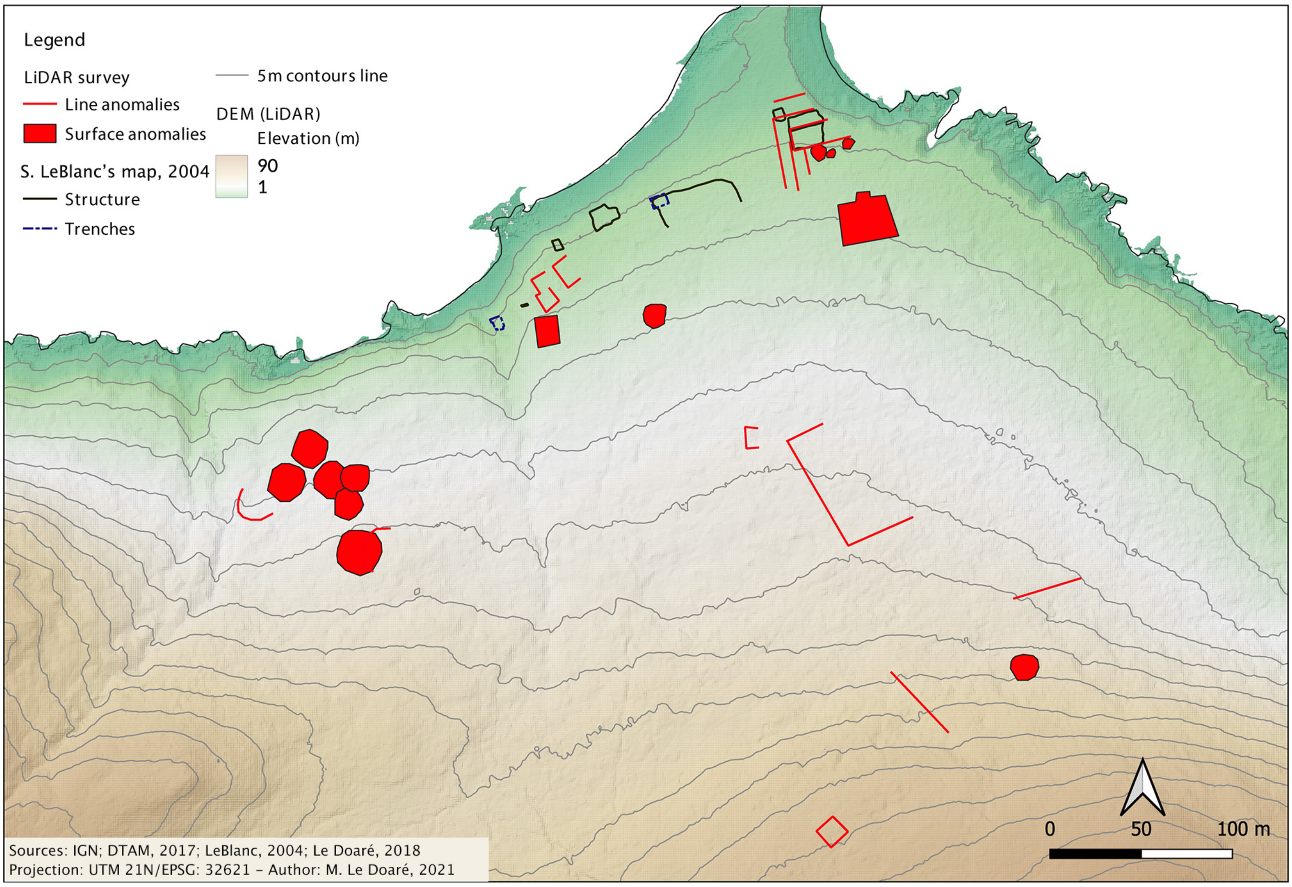


Fig. 3 – Anomalies detected at the Anse-à-Henry site using LiDAR in 2018 (map and analysis: M. Le Doaré).
***Fig. 3** – Anomalies détectées à l'aide du LiDAR sur le site de l'Anse-à-Henry en 2018 (carte et analyses M. Le Doaré).*

in situ, however, there are very few historical sources indicating human occupations in this area (fig. 4). This headland is located to the south of the island of Miquelon and it juts out to create the narrow mouth of the Grand Barachois lagoon. The vegetation is low and composed mainly of Gramineae, which allows for a good penetration of the LiDAR signal. J. Billy's (2014) findings that the headland was formed late compared to the rest of the isthmus, around the 16th century, when the first Europeans arrived on the island, make it possible to establish a dating terminus for the anomalies encountered on the headland. Based on the sources, we can put forward

Fig. 4 – Pointe aux Cacaouis (photo R. Auger).
***Fig. 4** – Pointe aux Cacaouis (cliché R. Auger).*

several hypotheses on the origin of these structures and their occupation. Aubert de La Rüe (1937) and Sasco (1931) mention traces of enclosures and encampments north of the Grand Barachois, though they remain vague about their locations. É. Aubert de La Rüe (1944) also refers to the presence of Mi'kmaq from Conne river, who came to the area in 1865 to hunt seals. D. Gauvain (1916) writes that fishers had settled on this headland. Finally, J. de La Roche-Poncié's 1841 map indicates a building, possibly a farm or a dwelling, as well as a name ("M. Le Fèvre"?). During field prospections, some Miquelon inhabitants have also mentioned the presence of an old farm in this area. Most of the structures have been identified during our surveys along with stoneware potsherds seemingly dating to the 19th century (Auger et al. 2019. The favourable position of this headland due to its sheltered location (from the prevailing winds and sea swell), its proximity to numerous resources (scallops, seals, fish) and its accessibility (from both the lagoon and the sea) makes it a strategic zone that is likely to reveal several occupations. Further research will help to refine its understanding. Its occupation should be linked to the shell mounds located to the north of the Grand Barachois and to other possible structures around the lagoon.

The sites identified on the archipelago using these LiDAR data thus have considerable potential, particularly for the modern period. It has enabled us to map the areas of potential archaeological interest, to orient future prospections and to highlight potential archaeological and historical clusters, particularly around the Grand Barachois.

3. CRUCIAL MONITORING OF THE EROSIVE DYNAMICS AT THE ANSE-À-HENRY SITE

3.1. A site subject to major erosive phenomena

The Anse-à-Henry site is located at the northern end of the island of St. Pierre (fig. 5). It occupies an area of morainic deposits approximately 300 m long west to east and 150 m wide north to south. Forming an isthmus, the area slopes gently towards the sea to the north and ends in a low-lying topographical bench connected to a small rocky outcrop called the Rocher de La Vierge (fig. 6). There is a perennial stream situated to the west around which, according to the results of the excavations carried out in 2000 and our own recent prospections, the prehistoric occupations were concentrated.

The soft cliffs at Anse-à-Henry are very exposed to the weather and are regularly undermined by the sea during winter storms (fig. 7). On both sides of the site, the coastline is affected by a rapid retreat at an average rate of 0.5 m/year (LeBlanc and Rabottin, 2005; Le Doaré, 2018). The cross-sections extracted in these heterometric, loosely compacted moraines reveal a large number of lithic remains at a submittal archaeological level just below the topsoil. Anse-à-Henry also lies below a rocky slope and is an outlet zone for several ponds, peat bogs and streams that have their sources in the island's hills. Because the island's bedrock is impermeable, all precipitation flows on the surface and impact the sedimentation processes around the site. Rainfall on the archipelago is high, averaging 1.326 mm/year (Météo France, 2020). The spring snowmelt combined with rainfall increases the volume of surface runoff. In winter time, the cold oceanic climate is marked by alternate freezing and thawing. These alternations can lead to frost shattering, which can cause instabilities on the rocky coasts and the occasional landslides. This erosion process is clearly visible on the southeaster flank of Pointe à Henry, where plurimetric basalt boulders are scattered about the upper beach having come away from the outcrop.

3.2. Methodology for the topo-morphological monitoring of Anse-à-Henry

In 2019, we began the topo-morphological monitoring to determine the erosion processes along the Anse-à-Henry coastline. A set of topographic markers was installed and connected to the IGN (Institut National de l'Information Géographique et Forestière) geodetic marker located on Mont Trépied, the highest point on St. Pierre. Topography was reconstructed using the "structure from motion" method based on aerial images taken on a Phantom IV Pro drone at an average altitude of 50 m. That information was processed using Agisoft Metashape software to produce an orthophotograph and a Digital Elevation Model with a resolution of 2 x 2 cm on the ground. A set of targets installed on the ground and surveyed with DGPS allowed the georeferencing of these data with an estimated reliability of ± 3 cm in *X* and *Y*, and ± 2 cm in *Z*. The acquisitions are ongoing and will be compared on a yearly basis to measure the erosion phenomena and determine the respective part of subaerial and marine processes.

Our initial results have already revealed the sectors most affected by erosion processes. Sector 5 in figure 8 is the most impacted by marine and subaerial erosion. The top of the cliff shows large scars indicating extensive slides of deposits towards the base of the cliff, probably during spring snowmelt and following episodes of heavy rainfall. Runoff and surface water saturation cause the moraine deposits to migrate downslope. Surface water runoff leads to gullying of the slopes in the newly exposed deposits (fig. 9). The base of the slides locally covers the upper beach and seems to be rapidly removed by wave actions. This part of the coast is directly exposed to west-northwest swells. The base of the slopes is therefore frequently eroded, maintaining a sufficiently steep slope to trigger further landslides. This combination and sequence of processes over time is accountable for the rapid retreat of the coastline.

Fig. 5 – View from the southwest of the Anse-à-Henry headland located in the north of the island of St. Pierre. On the left, the island of Grand Colombier (photo G. Marchand).
***Fig. 5** – Vue depuis le sud-ouest de la pointe de l'Anse-à-Henry, située dans le nord de l'île de Saint-Pierre. À gauche, l'île du Grand Colombier (cliché G. Marchand).*

Fig. 6 – View of the site from the north, with Rocher de La Vierge in the foreground and the low-lying area behind (photo P. Stéphan).
***Fig. 6** – Vue du site depuis le nord, avec le rocher de La Vierge au premier plan et la zone basse derrière (cliché P. Stéphan).*

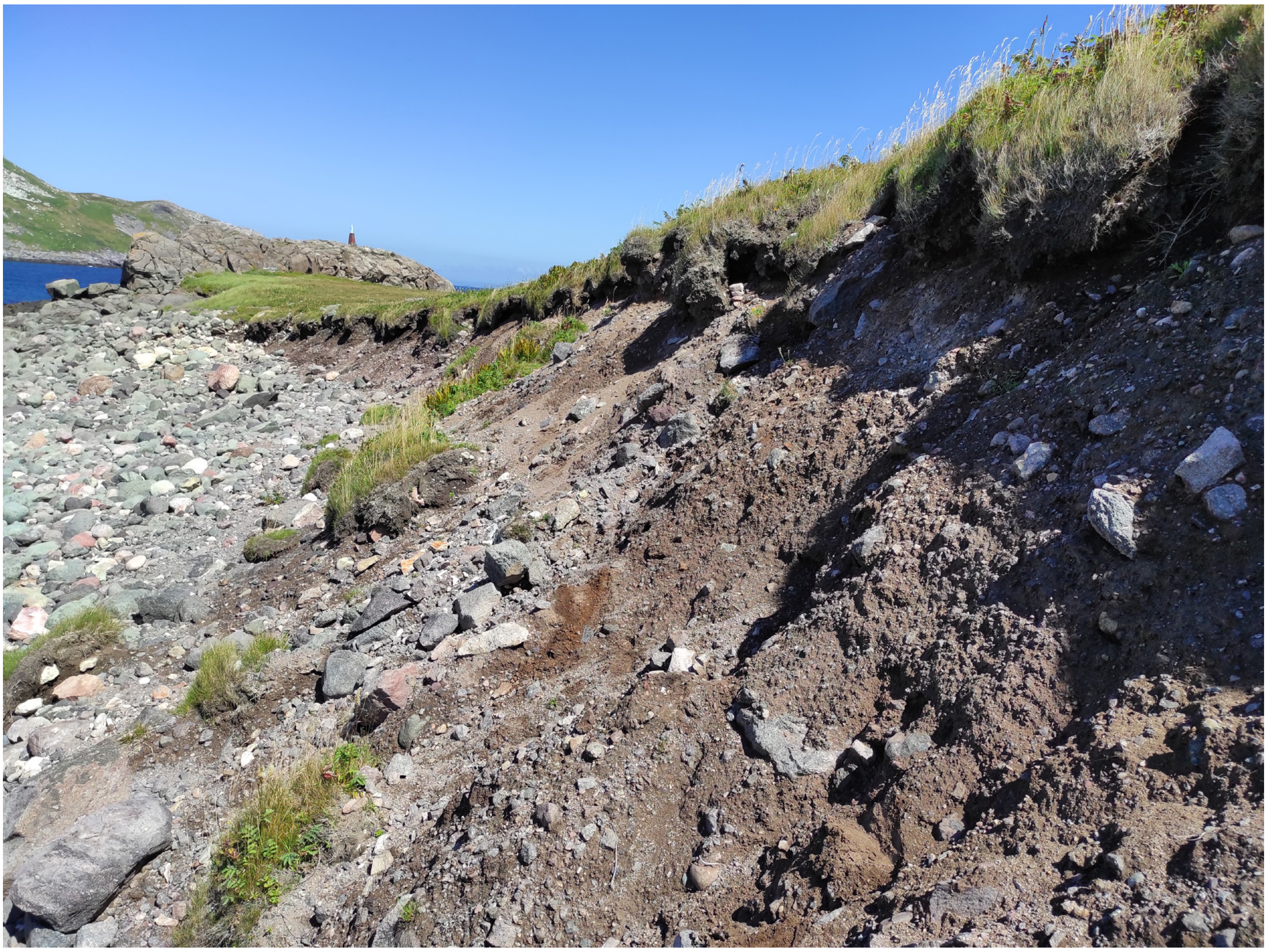


Fig. 7 – Erosion of the cliff in the western cove of Anse-à-Henry in August 2020 (photo G. Marchand).
***Fig. 7** – Érosion de la falaise dans l'anse ouest de l'Anse-à-Henry en août 2020 (cliché G. Marchand).*

3.3. Shoreline survey

The pluri-decadal shoreline changes were reconstructed from a digital processing of the aerial photographs taken by the IGN between 1952 and 2017. Using ArcMap software, the historic images were geometrically rectified and georeferenced from a set of fixed control points common with the IGN orthophotography dating from 2017. For the year 2019, the coastline was surveyed in the field with DGPS. The supratidal vegetation limit, which is easily identifiable in the aerial images, was taken as the reference baseline corresponding to the coastline. On the soft cliff sectors, the top of the slopes was also used as a reference baseline for digitising the coastline. The shoreline advance and retreat values were measured along transects perpendicular to the shoreline and spaced approximately 10 m apart using the Digital Shoreline Analysis System add-in within the ArcMap software. Uncertainty in the positioning of the coastlines was estimated at ± 1 m.

3.4. Assessment of the initial geomorphological observations

The initial topo-morphological data acquired in September 2019, as well as the data we collected during our geomorphological field observations, have provided preliminary elements that improve our understanding of the erosive dynamics along the coastline as well as the action of certain processes in the area around the Anse-à-Henry site. Our analysis of the morphologies found along the shoreline recognised different sectors of the coastline, which were affected by either marine erosion processes (wave action) or subaerial processes (runoff, colluviation, etc.).

To the southeast of the site, the cove formed by morainic deposits corresponds to a small pocket beach flanked by two rocky headlands (fig. 8, sector 1). Subvertical cliffs around one meter height extend over a linear distance of approximately 100 m. This morphology reflects the regular mechanical action of the waves on the coastal slope. This sector is exposed to swells from the east. At the foot of these soft cliffs, the upper beach is mainly composed of pebbles and shows a berm several metres wide. The beach thus seems to benefit from abundant sedimentary input resulting from the erosion of the morainic deposits, which the coastal currents cannot carry to the open sea or to adjacent areas. Combined with a spring tide, the storm waves here have an abrasive load capable of undermining the base of the cliff and maintaining a steep slope. Erosion here takes place through a direct retreat of the coastline

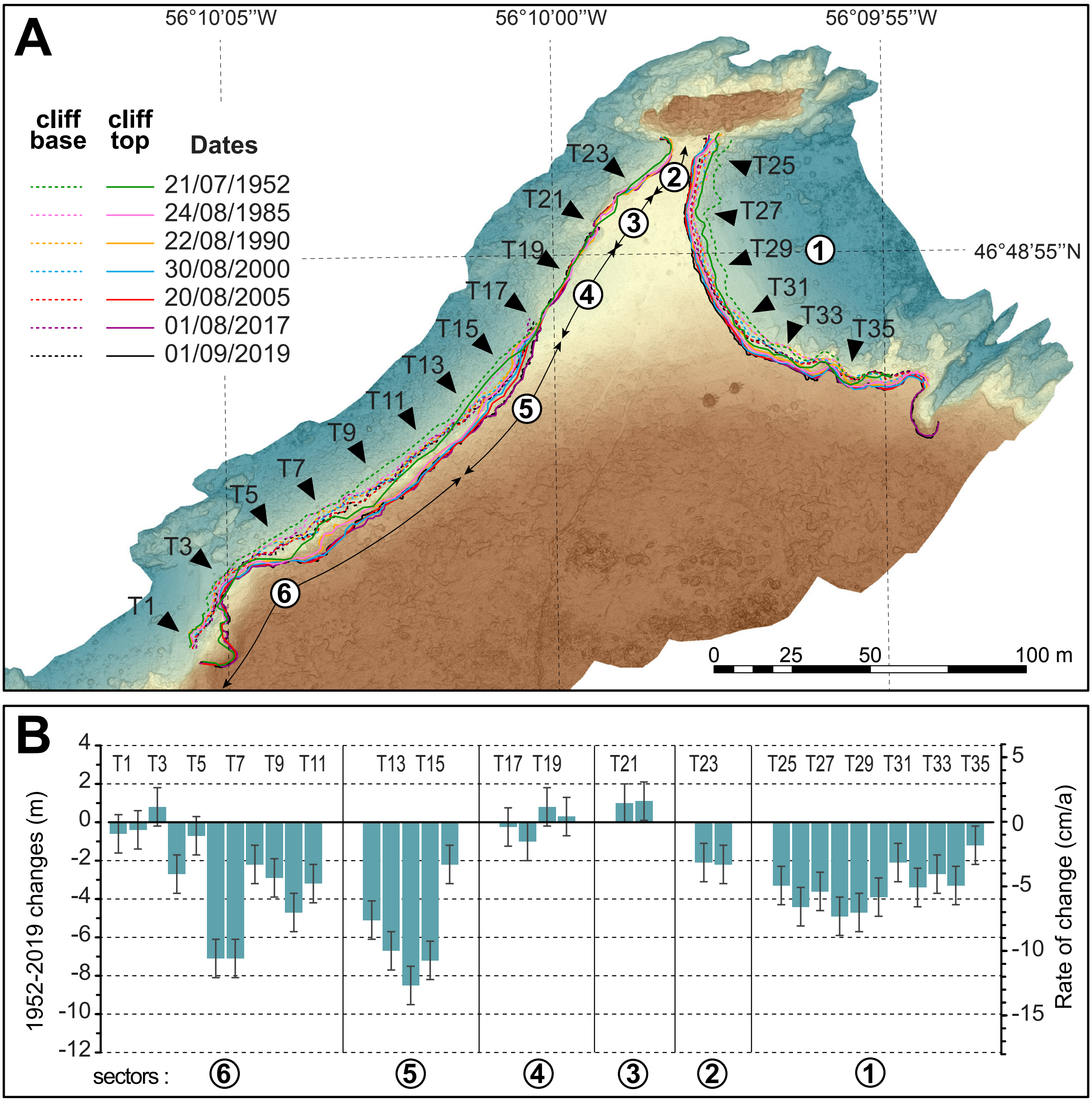


Fig. 8 – A: Location of Anse-à-Henry; B: Digital Elevation Model distinguishing six affected littoral sectors impacted, to varying degrees, by marine and subaerial erosion processes (map P. Stéphan).

***Fig. 8** – A : Localisation de l'Anse-à-Henry ; B : modèle numérique d'élévation distinguant six secteurs littoraux touchés, à des degrés divers, par les processus d'érosion marine et subaérienne (carte P. Stéphan).*

parallel to itself. The coastline retreat is estimated to be an average of 3.7 m for the period 1952 to 2019, which represents an erosion rate of 5.5 cm/year.

The southwestern part of the site presents more complex slope dynamics (fig. 8, sectors 2-6). The morainic deposits are thicker here with cliff heights of between 1 m and 4 m. The slopes appear to be subjected to a combination of marine and subaerial erosion processes. By following the coastline from north to south, the kinematics of the coastline coupled with a detailed analysis of the landforms allow us to subdivide this section into five distinct sectors:

1. Immediately to the south, the coastline is formed into micro-cliffs stretching over approximately 20 m (fig. 8, sector 2). The deposits are thus eroded over a few decimetres in height. A wide band of vegetation covers a mass of angular boulders at the foot of the slope, which themselves rest on a basalt outcrop with an irregular topography. The coastline retreat here is estimated at 2.2 m for the period 1952 to 2019.

2. Further to the south, in sector 3, the basalt micro-cliff stretches along approximately 20 m (fig. 8, sector 3) and shows no significant change from 1952 to 2019. Behind that stable section, we notice an anthropic

structure (stone slabs) in a stable state of preservation beneath a few centimetres of topsoil. The presence of such structures in this sector, which is protected from the waves by an outcrop does not appear to be affected by erosion.

3. To the south of this rocky section, the coastline corresponds to a boulder barrier approximately thirty metres in length, the top of which is partly covered by vegetation (fig. 8, sector 4). Measurements taken between transects T17 and T20 show no significant shoreline change over the last seven decades. The boulder accumulation results from a northward drift along the shore. Farther south, the crest elevation is lower and it facilitates the projection of boulders by storm breaking waves several metres as indicated by numerous scattered boulders distributed over the ground.

4. Sector 5 corresponds to soft cliffs formed in the glacigenic deposits which extend approximately 60 m farther south (fig. 8 and fig. 9). The height of the cliffs increases from 1.5 m to over 3 m from north to south. The slope gradient ranges from 70% to 100%. This sector is affected by strong marine and subaerial erosion processes. As recorded along the transect T14, rates of shoreline retreat are up to 10 cm/year and 13 cm/year at base and the top of the cliff, respectively. The mean values of shoreline retreat range from 4.1 m to 5.9 m from 1952 to 2019. Large scars on the top of the cliffs indicate mass sliding, probably during spring thaws and following episodes of heavy rainfall (runoff and surface water saturation of the moraine deposits). Surface water runoff also carves out numerous gullies in the newly exposed deposits. The base of the slides locally covers the upper beach and seems to be rapidly removed by the erosive action of the waves. This sector of coastline is directly exposed to west-northwest swells. The sea thus regularly clears the base of the slopes and maintains a sufficiently steep slope to ensure continuous landslides. This combination and sequence of processes over time explains the rapid retreat of the coastline in that sector.

5. Finally, sector 6 is an approximately 120 m stretch of soft cliffs leading to the outlet of an intermittent stream that is impacted by localised rotational slides identifiable as large scars at the top of the slope and in the tumbling down of large slabs of vegetation (fig. 8). The height of the cliff ranges from 5 m to 8 m and the removal of the eroded deposits at the base of the slope, because of erosion from the waves is slower, since that sector is less exposed to westerly swells. Nonetheless, the retreat of the cliff base reached 3 m between 1952 and 2019. At the top of the cliffs, fluvial gravel deposits have been identified and it seems to favour the infiltration of water into the substratum hence triggering of landslides (see infra). In its upper area, the cliff has retreated by 2.8 m over the period 1952-2019.

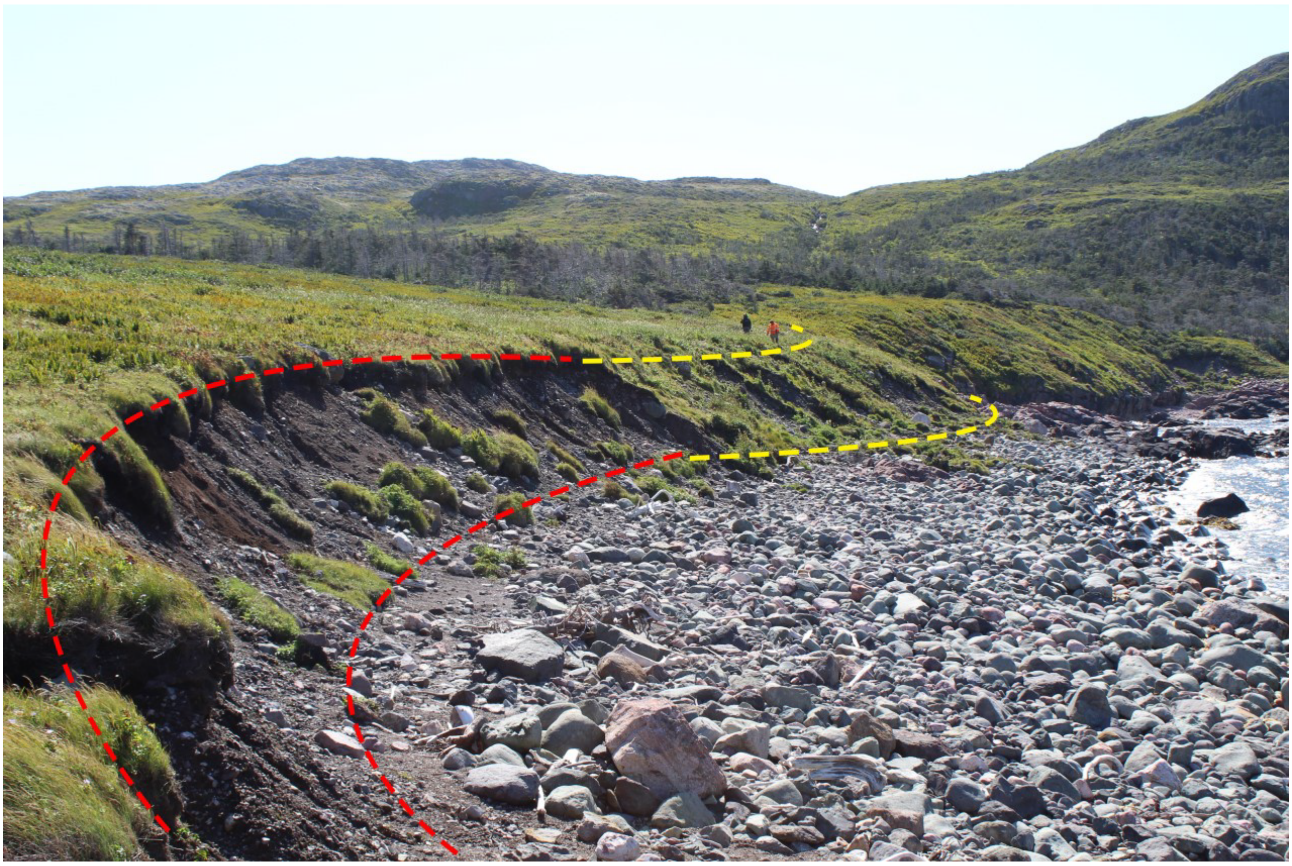


Fig. 9 – Anse-à-Henry, western cove. Sector 5 is marked in red, sector 6 in yellow (photo and CAD M. Le Doaré).
***Fig. 9** – Anse-à-Henry, anse ouest. Le secteur 5 est marqué en rouge ; le secteur 6, en jaune (cliché et DAO M. Le Doaré).*

4. ARCHAEOLOGY OF ANSE-À-HENRY SITE

4.1. Why are there so many human occupations in this area?

Research initiated at Anse-à-Henry since the 1980s has led to the identification of Paleo-Inuit, Amerindian and European human settlements. Those discoveries testify to the strong appeal of the northern point of the island of St. Pierre. Oriented towards the north and exposed to westerly and easterly winds, the site is difficult to gain access by sea except for the mouth of a small brook (Ruisseau de l'Ouest) which offers limited protection. Therefore, the continuous interest for such a location during the last four millennia raises the question of why there has been a recurrent interest for human settlements at that location. A clue may lay in the site location. Anse-à-Henry faces the island of Grand Colombier, a bird sanctuary situated on the opposite side of a 500 m-wide strait (fig. 5). That treeless island is a 1,200 m long and reaches an altitude of 149 m. Its rocky slopes covered with grass and fern offer the ideal conditions for nesting migratory seabirds. Thus, on a yearly basis, the occupants could count on aviary resources such as Atlantic puffins (*Fratercula arctica*) nesting in June, and also the only French breeding site for Leach's storm petrel (*Oceanodroma leucorhoa*). Common murre (*Uria aalge*) thrive in the colony where it stays during the winter. Razorbill (*Alca Torda*) are also plentiful on Grand Colombier where they lay their eggs in crevices on cliffs or among boulders (Bird Life International, 2021). Another important source of food that we still see going through the channel between the rocky point of Anse-à-Henry and Grand Colombier are humpback whales (*Megaptera novaeangliae*) and the finback whales (*Balaenoptera physalus*), dolphins (*Delphinus delphis*) and seals (*Phoca vitulina*). If the current ecological situation reflects those of the past, then the above parameters could explain the enduring value of this habitat. However, since the acidic soils preclude the preservation of osseous remains, the sources that can shed light on the nature of the human activities here are limited to the particularly plentiful lithic artefacts, the dwelling structures and the anthracological remains. Three main physiographic contexts can be defined here, namely the slope, the low-lying area and the terraces near the stream, whose morpho-sedimentary nature conditions the reconstruction of archaeological information.

4.2. Occupations on the slope

The excavation campaigns carried out by S. LeBlanc and J.-L. Rabottin focused on the slope to the west of the site. A total of 71 test pits measuring 0.50 m x 0.50 m were positioned with a grid at intervals of 5 m to 10 m (fig. 10). During the summers of 2003 and 2004, S. LeBlanc and J.-L. Rabottin concentrated on an area to the east of the stream, which they described as "central" in terms of the site occupation. Moreover, they conducted open area excavations over a surface area of 63 m² (36 m² in 2003; 27 m² in 2004). Immediately below the 20 cm thick plant litter, they discovered an abundance of lithic remains in association with combustion structures and activity areas such as flintknapping. Radiocarbon dating and tool typology showed a predominance of what was interpreted as being the ancestors of the Beothuk, preceded by the Middle Dorset occupants, whose way was paved by the early Paleo-Inuit Groswater phase.

In 2019, three new test operations were carried out on this slope, close to the edge of the eroding bank in order to identify future interventions and to hone our own methodology to dig in a disturbed sedimentary context (test pits G, H and I). Those 4 m² to 6 m² test pits allowed a different assessment of the sedimentary nature of this slope affected by various natural and cultural disturbances. The circulation of water under the recent stone beds (fig. 11, fluvial gravel deposits), within the soils themselves, severely constrained the excavation in sediments which appeared to have been reshuffled through time. Specifically, water ran under the fluvial gravel deposits bringing with it abundant lithic material. In addition, numerous boulders dotted about the surface, sometimes measuring over a metre in size. Upslope behind them, we systematically noted a depression often filled with stagnant water; in front a bulge of sediments pushed downslope. The whole process boulder migration resulted into the creation of a furrow which could measure up to 10 m in length and a slightly larger than the boulder. This is a well-documented colluvial phenomenon in the periglacial and montane contexts where huge boulders slide in response to freeze and thaw (Ballantyne, 2001), slowly migrating downslope and pushing a bulge of sediments in front of them. The vegetation covering the bulge and often hiding the presence of a furrow demonstrates the extreme slowness of the process (fig. 12). The "ploughing boulder" phenomenon is non-incremental and directly affects the stratigraphy of an archaeological site especially, when it is buried beneath a few decimetres of a peaty soil. Thus, our recognition of that geomorphological process has brought us to question the authenticity of many of the hearth features interpreted during the excavations carried out in the 2000s, since many of them were located against large boulders. Of course, there are combustion areas in association with fire cracked rocks, however, the challenge of the excavations in such context is to define the conditions of preservation of what appears to be a patchwork of some well-preserved and other less-preserved areas.

4.3. Western stream

To the west of the site, the low terraces of a small stream shows a different type of sedimentary context, less disturbed than the section described above. In 2002, S. LeBlanc and J.-L. Rabottin set up a 35 m² excavation area on a bench on the right bank (LeBlanc and Rabottin, 2003). A thin archaeological level was present under

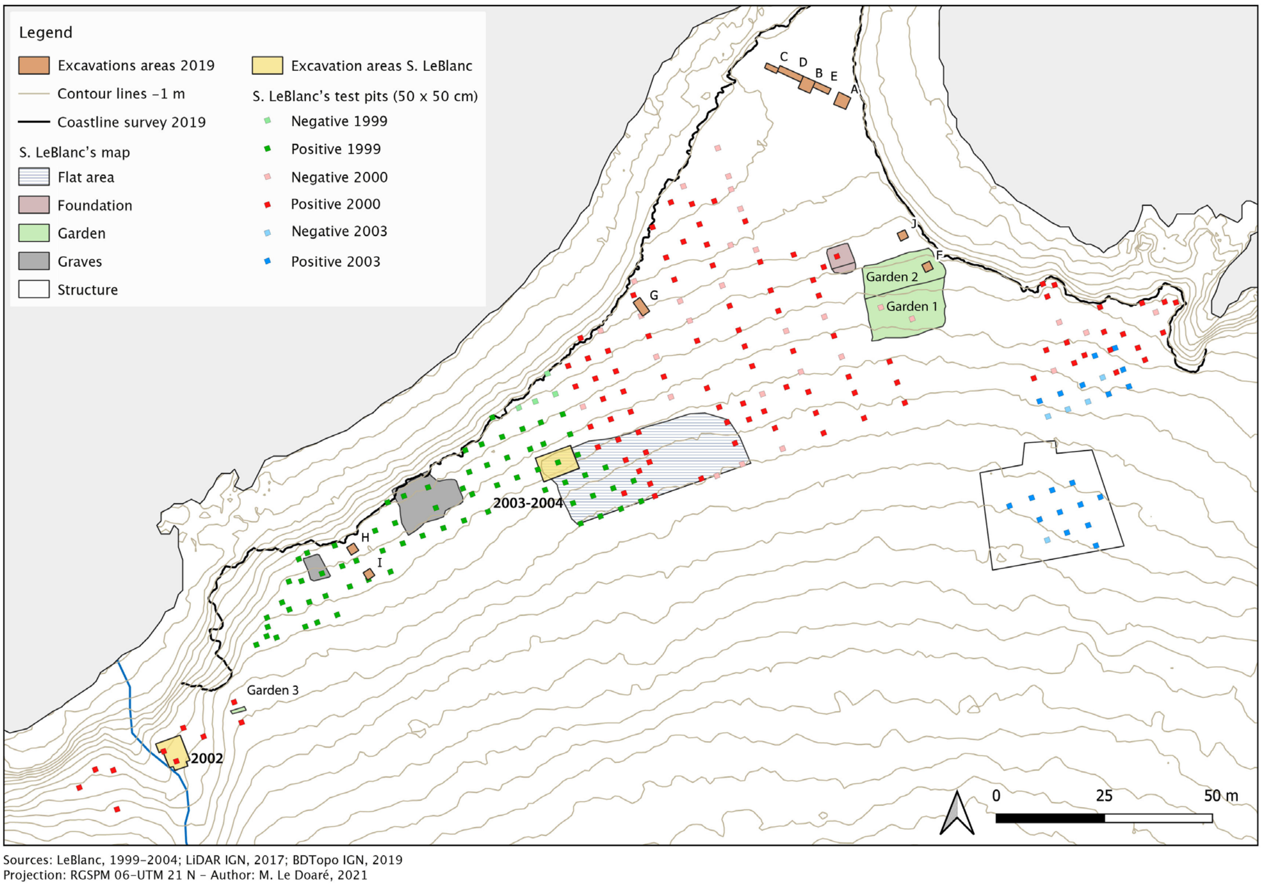


Fig. 10 – Plan of the various archaeological interventions carried out between 2000 and 2019 at Anse-à-Henry (LeBlanc and Rabottin, 2003, 2005; LiDAR, IGN, 2007; BDTopo IGN, 2019; CAD: M. Le Doaré).

***Fig. 10** – Plan des différentes interventions archéologiques réalisées entre 2000 et 2019 à l'Anse-à-Henry (LeBlanc et Rabottin, 2003, 2005 ; LiDAR, IGN, 2007 ; BDTopo IGN, 2019 DAO : M. Le Doaré).*

20 cm of sediment between the large natural boulders. Seven structures were identified: bowl-shaped firepits (structures 1, 4 and 6), a ring of stones interpreted as a feature to protect against the wetness of the ground (structures 3, 5 and 7) and a firepit dump (structure 2). The C^{14} dates from charcoal recovered from the firepits range from 660 CE to 1118 CE, with a concentration between 660 CE and 780 CE. These dates are consistent with the artefacts found at the site, including the lithic end-blades corresponding to the Beaches phase (McLean, 1994), an intermediate phase dating to between 1 CE and 1500 CE. Middle Dorset artefacts (end-blades and schist plates) were also found in that part of the site, and the dates are coherent with what we know of this well-documented phase in Newfoundland.

4.4. Occupations in the low-lying area

Even though the first mention of the site was based on the discovery of artefacts discovered in the eroding bank of the low-lying area near the point of land, no excavation was carried out in that sector prior to our 2019 intervention. Our pits were set up on an axis orthogonal to the headland between the two coves, over a length of 16 m with pits ranging from 1.5 m or 3 m in width. A total surface area of 42 m² was excavated (fig. 10, test pits A, B, C, D and E). Apart from erosion, no post-depositional disturbance had affected the prehistoric occupations in a stratigraphy that was less than half a metre in thickness (fig. 13). At some point, a cobble layer (US 2) was spread immediately underneath the actual vegetation. That cobble layer is interpreted as an overwash deposit coming from the eastern beach during a sudden submersion by one or more waves coming from either a storm or the 1927 tsunami which hit St. Pierre. The underlying level (US 3) is a peat layer devoid of any remains. The archaeological level underlying the peat (US 4) was remarkably well preserved (fig. 14) and yielded four areas of combustion measuring a few decimetres in diameter each (structures 4, 7, 8 and 9), a small quantity of pink rhyolite debitage (structure 3), a concentration of grey chert debitage (structure 6) and a small amount of crystal quartz debitage (structure 10). That archaeological level rested on a sterile till found throughout the entire site.

The 2,181 lithic artefacts found in the low-lying area came mainly from US 4. It comprises an asymmetrical bifacial artefact with a convex edge (fig. 15, no 6); asymmetric points with lateral notches (box based; fig. 15,

Fig. 11 – Test pit I in September 2019, bottom of the slope, top of the fluvial gravel deposit (photo G. Marchand).
Fig. 11 *– Sondage I en septembre 2019, bas du talus, haut du dépôt de gravier fluvial (cliché G. Marchand).*

Fig. 12 – A ploughing boulder, with a bulge on the left and its upstream furrow on the right, at the bottom of the Anse-à-Henry slope (photo G. Marchand).
Fig. 12 *– Un bloc de labour, avec un bourrelet à gauche et son sillon amont à droite, en bas du versant de l'Anse-à-Henry (cliché G. Marchand).*

Fig. 13 – Northern cross-section of test pit E. The black-coloured archaeological level (US 4) is at the base, on the huge boulders level. The pebbles bed covering the isthmus is at the top of the stratigraphy under the vegetation level (photo A. Naud).

Fig. 13 *– Coupe transversale nord du sondage E. Le niveau archéologique de couleur noire (US 4) se trouve à la base, sur le niveau des énormes blocs rocheux. Le lit de galets recouvrant l'isthme est au sommet de la stratigraphie, sous le niveau de végétation (cliché A. Naud).*

Fig. 14 – Flat firepit (structure 8) on the left and a pile of grey chert debitage (structure 6) on the right, in US 4 of test pit D (low-lying area; photo L. Rousseau).

Fig. 14 *– Foyer plat (structure 8) à gauche et tas de débitage en chert gris (structure 6) à droite, dans l'US 4 du sondage D (zone basse ; cliché L. Rousseau).*

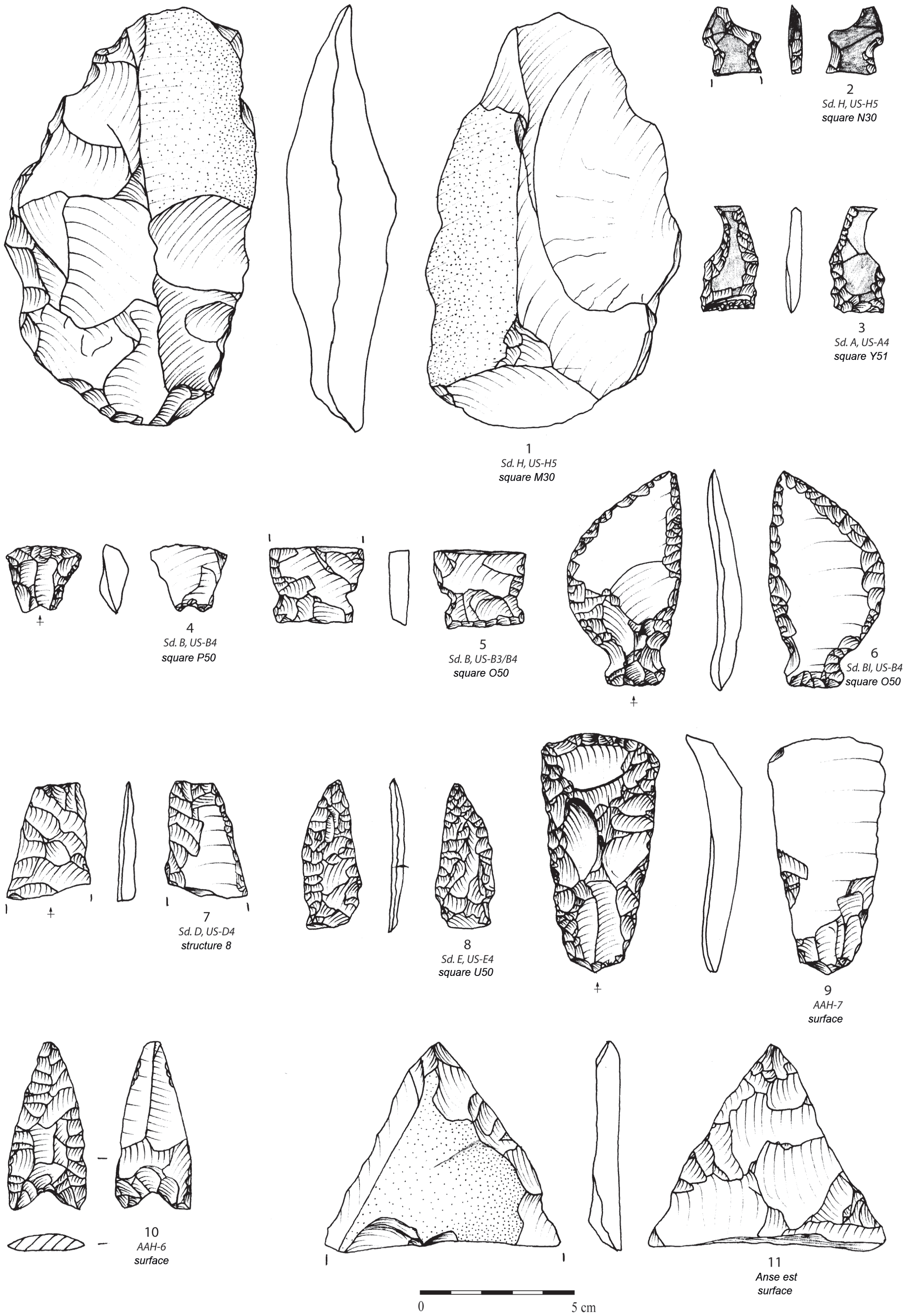


Fig. 15 – Some projectile points and tools (1: Drawing L. Bélanger; 2-3, 6, 9: Drawing L. Rousseau; 4, 11: Drawing F. Bisson; 5, 10: Drawing G. Marchand; 7-8: Drawing M. Pallares; 1-11: inking, shading and CAD L. Rousseau).

***Fig. 15** – Quelques pointes de projectiles et outils (1 : dessin L. Bélanger ; 2-3, 6, 9 : dessin L. Rousseau ; 4, 11 : dessin F. Bisson ; 5, 10 : dessin G. Marchand ; 7-8 : dessin M. Pallares ; 1-11 : encrage, ombrage et DAO L. Rousseau).*

no 5); a small bipoint; an end-blade with a straight base; a small, broad-faced trapezoidal flake scraper and a burin-like tool (fig. 15, no 3). All these are characteristic of the Groswater phase as we know it from Newfoundland and Labrador (Auger, 1984; Erwin, 2003; Renouf, 2003). The C^{14} dates on charcoal from structures 6 and 9, (found near one another), range from 500-400 BCE. Structure 7, to the east, gave a more recent date (360-200 BCE). This suggests two temporally distinct Groswater occupations within a single well-structured level.

4.5. Notes on the cultural components detected

The various archaeological operations conducted at Anse-à-Henry have revealed a number of human occupations over a long period of time which are yet to be better differentiated spatially. As for the Amerindian components, they include the Maritime Archaic and a late tradition that we assume to be ancestral to the Beothuk. The Maritime Archaic complex, first defined by J. A. Tuck (1971), originated from the Atlantic provinces approximately 9000 BP; they roamed the Southern Labrador coast from 7500 to 3500 years ago and were in Port-aux-Choix, Newfoundland at least 4300 BP (Hood, 1993, p. 164). We attribute to those hunter-gatherer populations the earliest harpoon heads to (LeBlanc et al., 2001). The late tradition concept brings together several cultural groups that succeeded one another from the beginning of the Common Era to the European arrival, in particular complexes such as the Cow Head, the Beaches and the Little Passage. Their stemmed arrow fittings stems or side-notched points are characteristic of some of these groups. That technical evolution is likely to be linked to changes in the subsistence economy with a shift from hunting marine mammals to land mammals (ibid.).

The Paleo-Inuit tradition is represented here by the Groswater and Middle Dorset phases. The Groswater, which takes its name from the eponymous site in Labrador (Fitzhugh, 1972), is a cultural group dated, for the regions that concern us, to between 800 BCE and 100 BCE (Renouf, 1999; Betts and Hrynick, 2021). Bifacial points with lateral notches and a box base, burin-like tools, double points, small broad-faced scrapers and microblades are attributed to this cultural group (Lavers and Renouf, 2012). The Dorset phase, originally identified at Cape Dorset (Kinngait), an Inuit village situated on Dorset Island near the Foxe Peninsula in Nunavut, appeared nearly 2,500 years ago in the Eastern Arctic. A characteristic phase developed in Newfoundland (the Newfoundland Dorset) between 100 and 900 CE and extended to St. Pierre and Miquelon. Polished or finely worked stone endblades with straight or sometimes concave bases were hafted to harpoon heads. These distinctive endblades are present in large numbers both at Anse-à-Henry (fig. 15, no 10; fig. 16, no 2) and in Newfoundland (Renouff, 1999; Betts and Hrynick, 2021). This phase, which is typical in Newfoundland, is known as the Middle Dorset in Labrador, Nunavik and Nunavut and covers a comparable time span.

4.6. Radiocarbon dating: are there chronological gaps?

The excavations conducted by S. LeBlanc and J.-L. Rabottin between 2002 and 2004 were accompanied by 19 radiocarbon dates, seven obtained from the 2002 excavation area and 12 from the 2003-2004 area (table 1). The radiocarbon dating was carried out at the Brock University laboratory in St. Catharines, Ontario, Canada, using charcoal samples and allowing for correction of the carbon-13 isotope. This corpus was supplemented in 2019 by three new dates from the Laval University Radiocarbon Laboratory. While this may appear to be a significant number of radiocarbon dates, they do not cover the whole history of occupations at Anse-à-Henry (fig. 17). In particular, occurrences of Maritime Archaic are absent, while there appear to be gaps between the attested cultural phases. The archaeological assessment carried out in 2019 proposes a new reading of the sedimentary context, which seems to be marked by substantial post-depositional upheavals on the slope, resulting in a displacement of the fine elements. This is nevertheless offset by the fact that the sunken structures do not seem to have been affected to any great degree by the taphonomic phenomena of the site; thus, the dates obtained within the structures in the early 2000s show a coherence, however, the same cannot be said for those collected from outside the structures in 2003-2004, the latter are rather useless. In summary, if we discard the 12 dates coming from the 2003-2004 excavations and retain only the dates obtained on the charcoal from the firepits, that is the seven dates obtained in 2002 and the three dates we obtained in 2019, then we can confidently identify three cultural phases, each with a specific occupation period:

- phase 1: 500-200 BCE, Groswater (low-lying area or north zone);
- phase 2: 660-940 CE, Middle Dorset or Recent Period (slope);
- phase 3: 1320-1625 CE, Recent Period (slope).

Repositioned spatially, phase 1 was found in the low-lying area of the site near Rocher de La Vierge (also called “the north zone”), phase 2 was found on the slope in the two areas excavated in the 2000s, and phase 3 was recorded exclusively in the middle of the slope in the open area excavated in 2003 and 2004. Two phase 1 dates from an extremely erratic sedimentary context, suggest early occupations in the middle of the slope, but these are chronologically inconsistent with the low-lying area dates, one of which is older (BGS-2492) and one more recent (BGS-2614). By adopting this sampling strategy centred exclusively on the structures, the initial notion of continuous occupations from the Maritime Archaic to the recent period becomes irrelevant. There are substantial chronological gaps between 200 BCE and 600 CE and between 940 CE and 1320 CE.

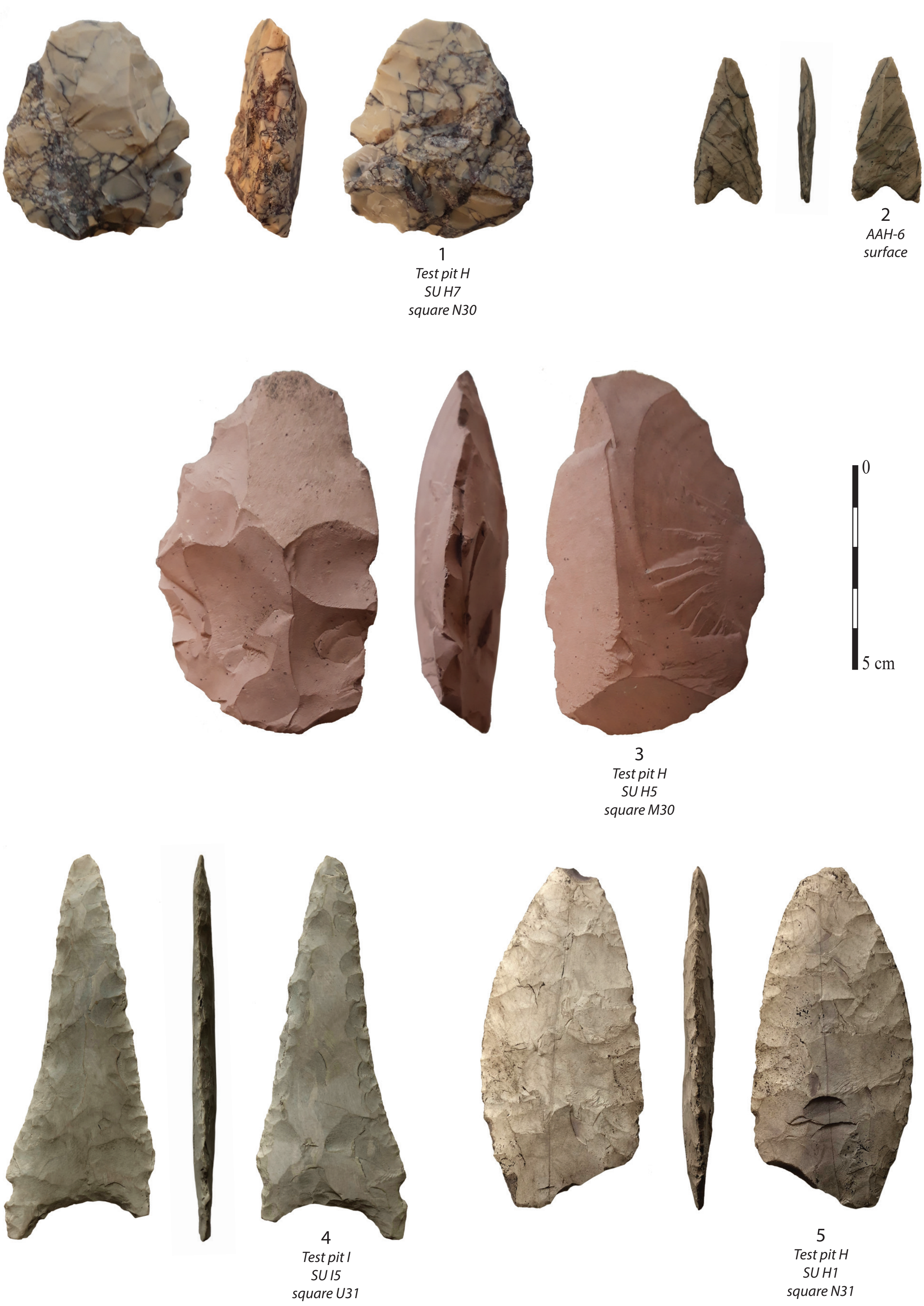


Fig. 16 – Examples of the most common rocks used in Anse-à-Henry toolmaking (excavation 2019). 1 and 2: Jasper from Grand Colombier (facies D); 3: Pink rhyolite (facies A); 4 and 5: Patinated rhyolite (facies C; photos and CAD L. Rousseau).

***Fig. 2** – Exemples des roches les plus courantes utilisées dans l'outillage de l'Anse-à-Henry (fouille 2019). 1 et 2 : Jaspe du Grand Colombier (faciès D) ; 3 : rhyolite rose (faciès A) ; 4 et 5 : rhyolite patinée (faciès C ; clichés et DAO L. Rousseau).*

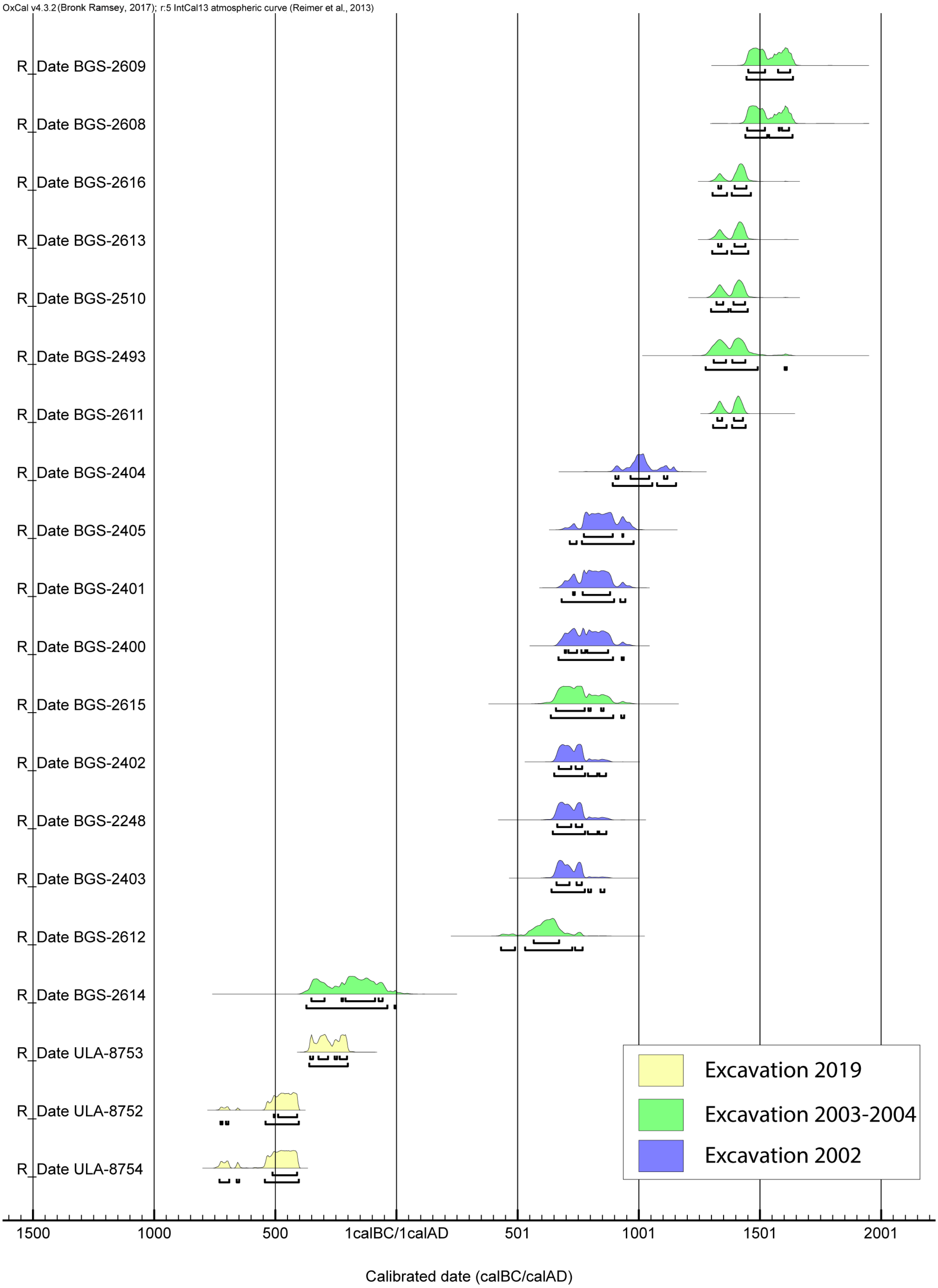


Fig. 17 – Distribution of radiocarbon dates (95.4% calibration with Oxcal 4.3) organised from oldest to most recent, with excavation areas indicated by colours (CAD G. Marchand, based on Oxcal 4.3; Reimer et al., 2020).

Fig. 17 *– Distribution des dates radiocarbone (calibration à 95,4 % avec Oxcal 4.3), de la plus ancienne à la plus récente ; les zones de fouilles sont indiquées par des couleurs (CAD G. Marchand, d'après Oxcal 4.3 ; Reimer et al., 2020).*

Code	Zone	Location	14C age (BP)	±	Calibration (cal. BC) – 95.4%	
ULA-8752	Excavation 2019 Test pit D	Test pit D US D4 N50/STR 6	2410	20	- 727	- 404
ULA-8753	Excavation 2019 Test pit D	Test pit B US B4 Q50/STR 7	2205	20	- 361	- 202
ULA-8754	Excavation 2019 Test pit D	Test pit D US D4 M51/STR 9	2415	25	- 731	- 404
BGS-2610	Excavation 2003-2004	Structure 1- Firepit	370	40	1446	1635
BGS-2609	Excavation 2003-2004	Structure 4 - Firepit	370	45	1445	1637
BGS-2608	Excavation 2003-2004	Structure 1 - Firepit	380	45	1441	1635
BGS-2616	Excavation 2003-2004	Structure 4 - Firepit	510	50	1305	1463
BGS-2613	Excavation 2003-2004	Structure 4 - Firepit	520	50	1304	1453
BGS-2510	Excavation 2003-2004	Structure 1 - Firepit	530	55	1299	1450
BGS-2493	Excavation 2003-2004	Structure 1 - Firepit	540	80	1277	1611
BGS-2611	Excavation 2003-2004	Structure 4 - Firepit	540	40	1307	1442
BGS-2615	Excavation 2003-2004	None	1280	70	638	940
BGS-2612	Excavation 2003-2004	Structure 3	1410	70	432	769
BGS-2614	Excavation 2003-2004	None	2140	65	- 373	- 4
BGS-2492	Excavation 2003-2004	Schist plate	2575	45	- 826	- 543
BGS-2404	Excavation 2002	Firepit 1	1025	50	893	1154
BGS-2405	Excavation 2002	Firepit 1	1175	45	716	979
BGS-2401	Excavation 2002	Firepit 1	1210	45	682	945
BGS-2400	Excavation 2002	Firepit 4	1230	50	669	938
BGS-2402	Excavation 2002	Firepit 6	1290	45	652	865
BGS-2248	Excavation 2000	Firepit 1	1300	50	646	867
BGS-2403	Excavation 2002	Firepit 6	1310	45	641	859

Table 1 – List of radiocarbon dates obtained on charcoal at Anse-à-Henry for all operations combined, ranked from most recent to oldest (LeBlanc and Rabottin, 2002 and 2005; and unpublished dates for the 2019 campaign). Calibration with OxCal 4.3 software (Reimer et al., 2020).

***Tabl. 1** – Liste des dates radiocarbone obtenues sur charbon de bois à l'Anse-à-Henry toutes opérations confondues, classées de la plus récente à la plus ancienne (LeBlanc et Rabottin, 2002 et 2005 ; et dates non publiées pour la campagne 2019). Calibration avec le logiciel OxCal 4.3 (Reimer et al., 2020).*

5. WAS THE ARCHIPELAGO PART OF A NETWORK IN THE DISTRIBUTION OF RAW MATERIAL? VOLCANIC ROCK QUARRIES AND RAW-MATERIAL TRANSFERS

5.1. Identification of worked ryolite at Anse-à-Henry

The use of local rocks can be easily detected at the Anse-à-Henry site from the abundance of flakes and biface preforms broken during preparation. A local origin is likely for these rocks, since nomadic groups would not have bothered to transport potentially flawed uncut boulders. The first phase of our research on the supply of workable rocks consisted in identifying the rocks used to make the tools (fig. 16). In the context of S. LeBlanc and J.-L. Rabottin's archaeological excavations (1997 to 2004), J.-L. Rabottin carried out an initial classification into 20 types, which are numbered 1 to 20 and displayed individually at Museum of L'Arche on St. Pierre. An examination of the lithic assemblage collected in 2019 and the discovery of certain deposits (Auger et al., 2019) have made it possible to group some of these types together to consider the extensive variability of volcanic rocks (table 2).

The dominant rock in our surveys was a glossy grey silicate (facies E), whose use is 98% attributable to the occupants of the low-lying area of Anse-à-Henry, in other words to the Groswater facies Paleo-Inuit. The facies D jasper was the second most common rock detected, but this was found almost exclusively on the slope, with tools attributable mainly to the Dorset period. The use of crystal quartz was also attributed to this period (LeBlanc and Rabottin, 2000, p. 15), but we found a considerable cluster in the low-lying area in the Groswater zone which may suggest that the space used during the Groswater phase may have been attractive to the Dorset as well. The pink rhyolites were the next most common (facies A and facies B), followed by facies C (patinated rhyolites). These were found in all areas of the site. Could the apparent diversity in the use of raw materials on this habitat over time correspond to a broad choice of geological deposits, or could it reflect local variations among the facies? The answer to this question inevitably lies in future studies of the extraction zones themselves.

5.2. Locating the rhyolite and ash tuff extraction zones

The second phase of our research consisted in ground surveys using geological maps and S. LeBlanc and J.-L. Rabottin's notes to identify certain extraction zones. This excluded, from the outset, the sedimentary silicates (facies E), which probably came from Cow Head in Newfoundland (Auger, 1984; Lavers and Renouf, 2012). The geological substratum of St. Pierre is mainly marked by intense explosive volcanic activity, dated between 585 and 575 million years ago, which left behind ash tuffs, lapilli tuffs and pyroclastic breccias (Blein et al., 2015). The resulting rocks suitable for tool production are fiamme ignimbritic rhyolites and silicified, very fine-grained ash tuffs**.** As we were able to observe, most of the rhyolites split naturally into plates measuring 10 cm to 20 cm long and 2 cm to 5 cm thick, which naturally configures them for bifacial productions with minor adaptations needed.

This identification of the lithology of the rocks used and/or present on the site must be considered in combination with their assumed geological location. How many geological deposits were actually exploited by the prehistoric occupants of the archipelago? What distances did they travel to obtain them? Was the supply local, or should we consider contributions from further afield? The accessibility of workable rocks as well as the knapper's

Name	Rabottin type	AAH-2019 Facies	Proportions in 2019 (%)
Homogeneous pink rhyolite	1, 2, 3, 5, 6, 13, 16, 17	A	9.4
Burgundy veined rhyolite	4, 9, 10	B	8.1
Patinated rhyolite	8, 18, 19, 20	C	3.8
Beige veined silicified tuffs	7a, 7 b, 12	D	31.9
Homogeneous glossy grey silicate	11	E	41.8
Blue-grey siliceous rock	14	F	Negligible
Reddish siliceous rock	15	G	0.5
Hyaline quartz	Crystal quartz	H	0.6
Brown quartzite sandstone		I	0.4
Other			3.5

Table 2 – Equivalence between the Rabottin types and the lithological facies established from worked lithic pieces found during the 2019 Anse-à-Henry excavation (AAH-2019).

***Tabl. 2** – Équivalence entre les types de J.-L. Rabottin et les faciès lithologiques établis à partir des pièces lithiques travaillées trouvées lors de la fouille de l'Anse-à-Henry 2019 (AAH-2019).*

selection principles and the values of certain rocks must all be considered in the study of human occupations and landscape perception. In the absence of ploughed fields on these islands, visual access to the substratum was gained through sea cliff cross-sections, the numerous windfalls in the low-lying forests, the periphery of huge boulders, which often leave large furrows devoid of vegetation, the edges of ponds, stream beds and even areas where the vegetation has been damaged by snow accumulations. Cliff bases were also explored, despite the difficulty to access them over scree slopes. Those provided opportune access to a series of geological strata in the slope deposits. In terms of cumulative surface areas, the observation windows were quite large and offered a good readability. We also noted that all the topographic contexts were accessible, whether located at the top of hills or the bottom of valleys. After identifying the areas of interest on the geological map, a random but sustained reconnaissance was carried out, with multiple visits over the course of the year.

Three provenance areas were reported by S. LeBlanc and J.-L. Rabottin for St. Pierre: the eastern part of the island of Grand Colombier, the Cailloux Rouges headland in the west of St. Pierre and the Cap Rouge headland in the northeast (fig. 18). Grand Colombier supplied a creamy yellow siliceous rock marbled with blue or violet veins and is rather unique in appearance (fig. 17, no 1 and no 2; fig. 19, photos GC-1 to GC-4). Those rocks are thought to be silicified tuffs due to the circulation of hydrothermal fluids (Olivier Blein: *in litteris*). On the site itself, at the eastern end of the island, we found no obvious traces of exploitation, but visibility was poor due to a thick vegetation cover of grass, fern and crowberries, which had no doubt been boosted by the concentration of guano on the ground. We collected raw material samples from four zones on Grand Colombier (GC-1, GC-2, GC-3 and GC-4).

Although the Cailloux Rouges headland does not provide any workable rock, we discovered a remarkable rhyolite quarry one kilometre to the south, which we propose to name Bois Brûlé (Marchand and Borthaire, 2020). This source of raw material extends over more than 20,000 m^2 and comprises at least seven pink, purple or black rhyolite outcrops (named SP-7, SP-8, SP-9, SP-10, SP-11, SP-12 and SP-13; Marchand and Borthaire, 2020). Thousands of flakes and unfinished bifacial artefacts strewn across these outcrops indicate intensive exploitations that are yet to be dated. To the northeast of the island, in the upper part of the volcanic formations, only the Étang de l'Île outcrop (SP-4) shows traces of spatially confined exploitations. We also sampled two comparatively small but good quality materials in the cliffs nearby (SP-5 and SP-14). Finally, three other rhyolite quarries, each a few metres in diameter, were discovered by Borthaire more than 30 km away from Anse-à-Henry in the south of Miquelon Island (MIQ-6, MIQ-7 and MIQ-8). Therefore, the question should be raised whether these recently discovered deposits were all exploited by the archipelago's occupants.

5.3. First results from the geochemical analyses of the worked siliceous rocks and quarries identified

To answer the above questions, geochemical analyses were conducted on rock samples from the quarry sites and on abandoned worked rock from the Anse-à-Henry archaeological site. One or two samples were analysed from each quarry. The analyses consisted firstly in specifying the nature of the volcanic rocks collected from the deposits. We then determined the most discriminating chemical elements in order to characterise the St. Pierre and Miquelon quarries. The objective was to compare the compositions of the worked rocks from the Anse-à-Henry habitat with those from the St. Pierre and Miquelon quarries. An origin can be proposed when there is a correlation between geochemical composition of the objects and what was recovered at the quarry.

The instrument used for our chemical analyses was a Thermo Scientific Niton XL3t Goldd+ portable X-ray Fluorescence (XRF) spectrometer. This instrument was used in the "TestAll Geol" pre-programmed mode. At least three analyses were performed on each sample and, where possible, on three different zones. This revealed the heterogeneity of the samples. We prioritised flat surfaces and avoided corrupted or patinated areas. The elements we detected using this method ranged from magnesium to uranium. The elemental chemical compositions were adjusted using international standards (UB-N, MAN, Mica-Fe, NIST610, NIST612 and NIST614) analysed under the same conditions.

Table 3 presents the mean spectrometer results identifying 22 chemical elements for each sample. The analyses confirmed that all the rocks were siliceous and that the SiO2 contents exceeded 69%. We compared the SiO2 contents for each analysis with the Zr/TiO2 ratio, which, expressed in the Winchester and Floyd diagram, made it possible to specify the volcanic nature of these rocks (fig. 20). We expected most of the rocks from the deposits to have a chemical composition like that of a rhyolite, but this was not the case. On the contrary, there was a considerable dispersion of values, which was not reported in a previous geochemical study of the acidic volcanic rocks in St. Pierre and Miquelon (Rabu et al., 1996).

This discrepancy in results may be related to the silicification phenomena that had locally affected the rocks during ignimbritic effusions. It is also possible that there were subsequent alteration processes that had affected the chemical composition of the rocks. Looking at the results, it is easy to distinguish between two sets of formations. The first concerns the rocks from the Grand Colombier deposit, whose SiO_2 concentration exceeds 85%, associated with a low Al_2O_3 concentration (less than 2%). This is an ancient, highly silicified rhyolitic tuff. The second set comprises the rest of the rocks in the study. This set has an Al_2O_3 content of more than 4% and a SiO_2 content that ranges from 69% to 85%, sometimes even within a deposit.

To distinguish the formations of this second set, we applied an additive log-ratio transformation of the data

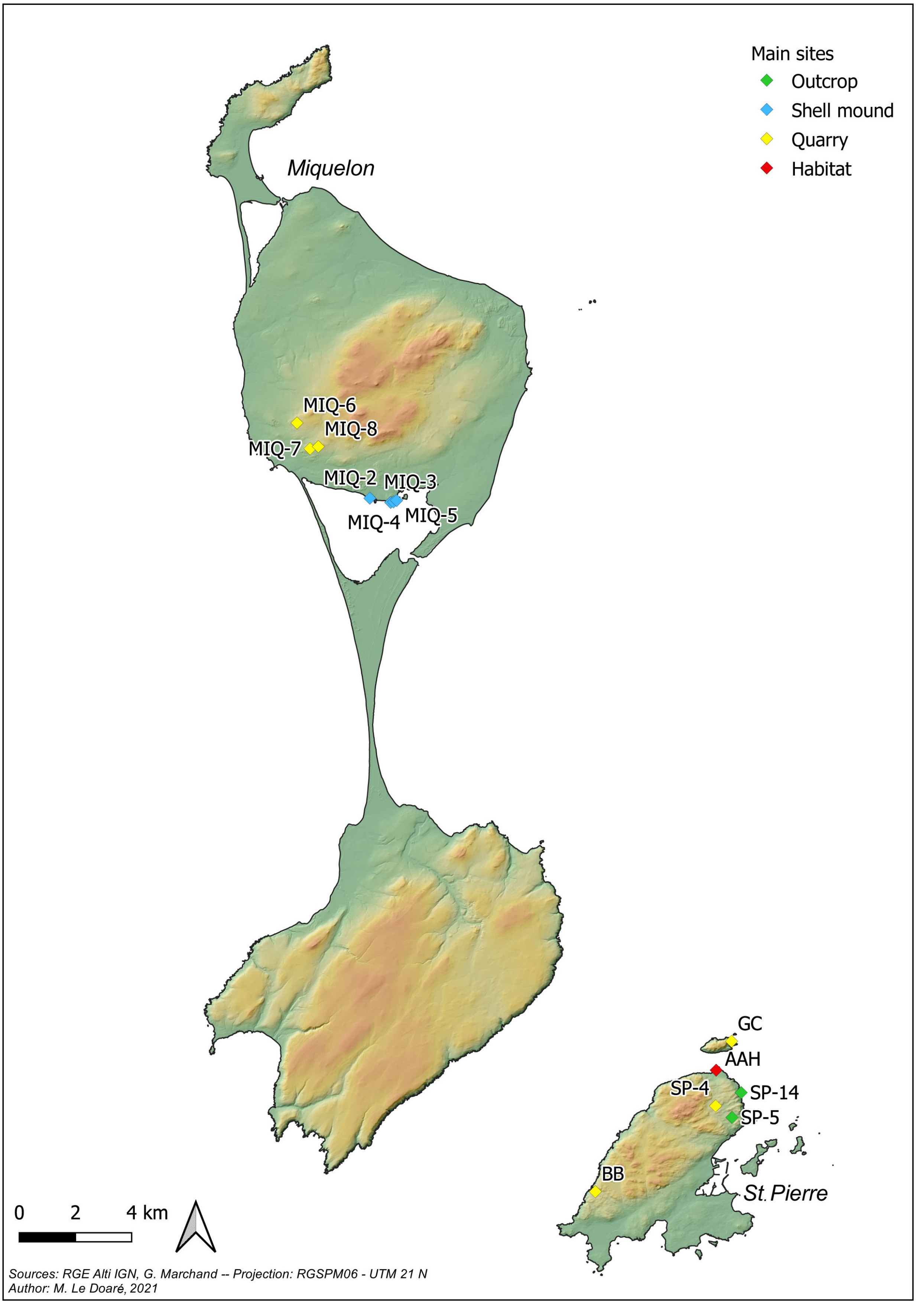


Fig. 18 – Main archaeological sites discovered by our team in 2019 and 2020. The Bois Brûlé quarry includes zones SP-7, SP-8, SP-9 and SP-10, which have been the subject of geochemical analyses (CAD M. Le Doaré, based on IGN map).

***Fig. 18** – Principaux sites archéologiques découverts par notre équipe en 2019 et 2020. La carrière du Bois brûlé comprend les zones SP-7, SP-8, SP-9 et SP-10, qui ont fait l'objet d'analyses géochimiques (CAO M. Le Doaré, d'après la carte IGN).*

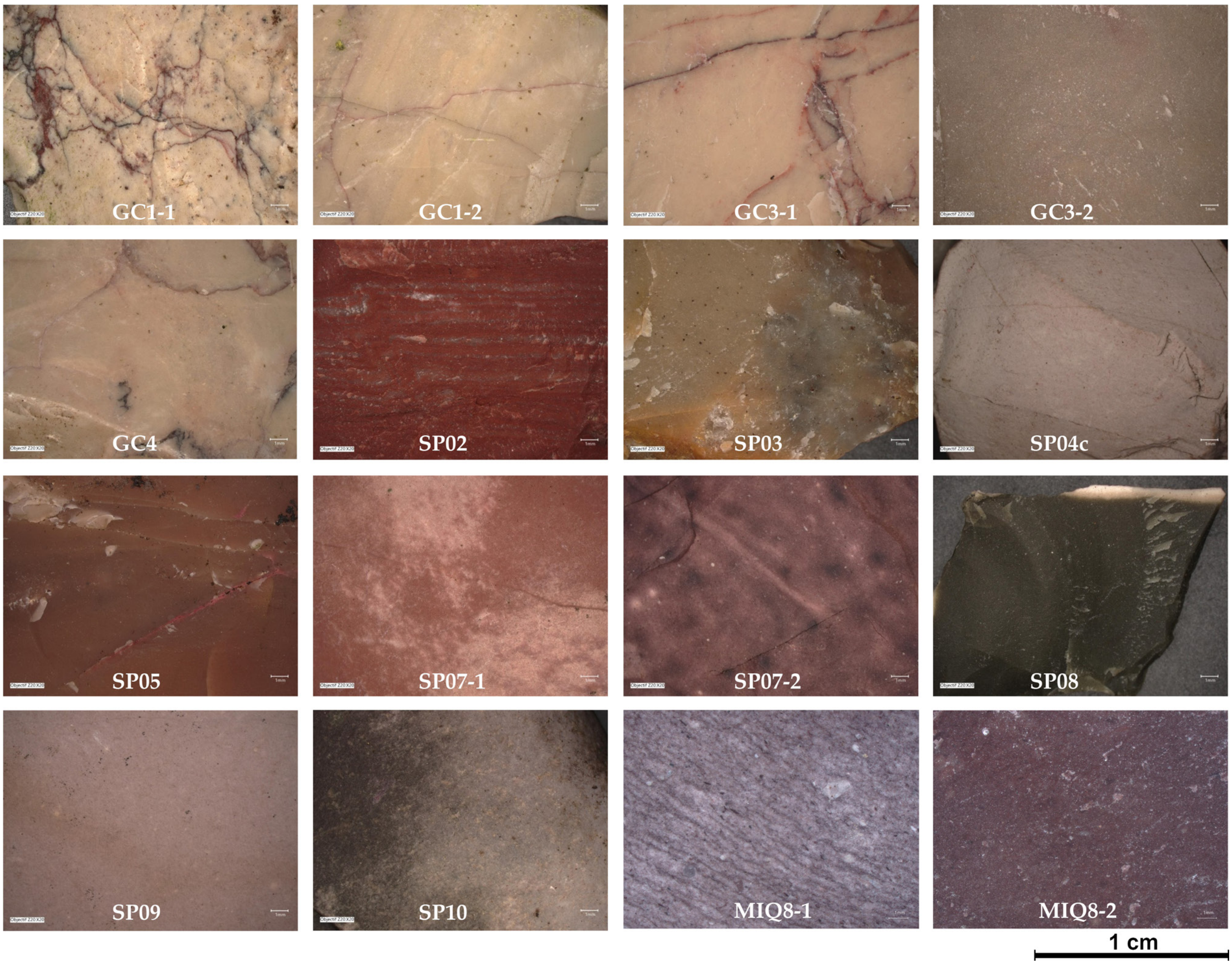


Fig. 19 – Macrophotographs of various rocks from the rock deposits discovered on the archipelago.
Photo dimensions W: 15 mm x H: 10 mm (photos M. Guiavarc'h).
***Fig. 19** – Macrophotographies de différentes roches issues des gisements rocheux découverts sur l'archipel.*
Dimensions des photos L : 15 mm x H : 10 mm (clichés M. Guiavarc'h).

following J. Aitchison and M. Greenacre's (2002) recommendations, a method previously developed on and for the study of Corsican rhyolites (Leck et al., 2018). This data processing was necessary because the results provided by X-ray fluorescence spectrometry are compositional data expressed as proportions (in ppm in our case). This transformation broke down the data interdependence and reduced the dispersion of the results linked to the heterogeneity of the rhyolites, which varied in degree, as we can see with the silicification phenomena. The element Si was therefore chosen as the log-ratio denominator. After transformation, the contents of the elements K, Ti, Zr, Mn, Rb, Fe, Ba, Nb and Sr, as expressed in different bivariate diagrams, allowed us to visualise the characteristic compositional zones of the rocks from the deposits. With this set of elements, the composition of the rock from the Cap Rouge deposit (SP-5) is particularly differentiated from the other compositions. In general, the chemical compositions of the rocks from the different Bois Brûlé deposits are similar. The two SP-7 facies can nevertheless be differentiated from the other Bois Brûlé deposits. A graph comparing the Ba and Nb contents shows the distinction between the rocks from Miquelon and those from Bois Brûlé in St. Pierre, those corresponding to sample SP7-2 (fig. 21).

The analyses conducted on the archaeological objects from the Anse-à-Henry site, which were selected according to their macroscopic type, were then compared with the data from the deposits. We noted that the occupants of the Anse-à-Henry site mainly obtained their raw materials from the Bois Brûlé deposit in St. Pierre and the Grand Colombier deposit. Types 7a and 7b from the site correspond to rocks from the Grand Colombier quarries GC-1, GC-3 and GC-4. The SP-7 quarry was used at Bois Brûlé; chemical data from sample SP-7-2 are like types 4, 9, 10 and 9-10 (fig. 21). The other quarries at Bois Brûlé are more difficult to distinguish from one another. Despite their different macroscopic aspects, their chemical compositions are similar. In addition, it seems the Miquelon deposit provided material for type 16, but this important connection is yet to be confirmed, because it is based on a single element: barium. The association of the archaeological objects with the SP-3, SP-4 and SP-5 quarries is not an obvious one. We nevertheless noted that type 16

Deposit		Al2O3	SiO2	P2O5	K2O	CaO	TiO2	MnO	Fe203	Total	Ba	Ni	Cu	Zn	Ga	Rb	Sr	Zr	Nb	Sn	Sb	Pb	Th	U
GC1-3-4	mean	0,466	92,769	0,37	-	0,025	0,429	0,013	0,085	**94,158**	65	75	8	-	-	-	14	172	7	-	-	13	3	-
	standard deviation	0,083	3,168	0,199	-	0,026	0,179	0,002	0,127	**3,011**	41	17	2	-	-	-	25	63	3	-	-	7	1	-
MQ8	mean	7,463	74,656	0,364	0,695	0,156	0,41	0,03	1,008	**84,781**	147	95	8	14	8	16	25	269	15	-	-	11	5	6
	standard deviation	1,043	9,401	0,16	0,116	0,071	0,349	0,003	0,283	**9,603**	74	14	1	4	1	1	2	30	1	-	-	1	1	1
SP2	mean	8,334	69,441	0,283	2,499	0,281	0,19	0,049	1,423	**82,5**	816	126	10	25	9	67	80	180	9	47	133	15	5	8
	standard deviation	1,277	2,593	0,027	0,438	0,078	0,072	0,015	0,755	**2,937**	182	13	1	8	2	6	18	41	4	24	68	2	1	1
SP3	mean	6,258	82,469	0,281	2,631	0,144	0,111	0,024	0,338	**92,255**	464	101	-	14	-	109	28	99	6	50	128	17	5	8
	standard deviation	0,568	7,905	0,048	0,46	0,075	0,024	0,003	0,034	**7,25**	128	21	-	8	-	7	1	4	2	9	24	5	1	2
SP4	mean	4,702	89,55	0,277	2,479	0,055	0,046	0,024	0,326	**97,46**	305	161	3	10	0	123	17	55	7	49	125	3	5	5
	standard deviation	0,605	0,915	0,016	0,187	0,009	0,004	0,003	0,003	**1,343**	14	126	5	2	0	4	3	4	1	8	16	5	0	5
SP5	mean	2,762	79,491	0,322	0,339	0,094	-	0,016	0,07	**83,1**	204	65	-	-	-	12	10	4	-	43	146	-	-	-
	standard deviation	2,285	10,553	0,06	0,17	0,052	-	0,004	0,012	**12,092**	14	6	-	-	-	2	5	1	-	3	12	-	-	-
SP7	mean	6,754	79,139	1,111	1,413	0,479	0,141	0,036	1,961	**91,034**	275	113	12	21	13	33	255	884	57	47	95	30	8	12
	standard deviation	1,498	5,4	0,573	1,168	0,884	0,099	0,023	1,068	**3,609**	95	24	2	10	4	26	290	158	8	10	22	18	2	4
SP8	mean	12,604	70,412	0,242	1,812	0,549	0,215	0,077	0,899	**86,81**	353	56	-	36	8	56	195	226	15	32	72	9	7	9
	standard deviation	0,103	0,511	0,039	0,021	0,006	0,008	0,002	0,009	**0,571**	15	17	-	2	1	1	3	2	1	2	10	0	1	1
SP9	mean	10,408	78,381	0,253	1,991	0,123	0,051	0,022	0,583	**91,812**	646	115	-	9	10	68	78	233	10	49	134	7	4	5
	standard deviation	0,3	1,755	0,036	0,073	0,007	0,007	0,003	0,016	**1,665**	21	12	-	4	3	2	2	2	1	7	11	1	0	4
SP10	mean	10,449	72,371	0,3	1,725	0,72	0,235	0,059	0,862	**86,721**	566	110	10	30	9	37	101	351	16	39	98	14	7	8
	standard deviation	1,433	2,872	0,026	0,079	0,435	0,062	0,026	0,333	**4,228**	131	26	2	14	2	1	36	25	2	27	63	5	2	2
SP11	mean	9,616	69,718	0,426	1,797	0,221	0,17	0,041	0,71	**82,699**	333	130	8	16	10	35	43	311	16	-	-	10	6	6
	standard deviation	0,399	1,297	0,054	0,053	0,007	0,001	0,005	0,036	**1,776**	9	20	1	1	3	1	8	11	1	-	-	2	1	1

Table 3 – Data from the X-ray fluorescence spectrometry analyses averaged for each deposit discovered at St. Pierre (SP), Grand Colombier (GC) and Miquelon (MQ). The weights of oxide concentrations are given in % and the elemental concentrations in ppm; SD = standard deviation.

Tabl. 3 *– Données des analyses par spectrométrie de fluorescence X moyennées pour chaque gisement découvert à Saint-Pierre (SP), au Grand Colombier (GC) et à Miquelon (MQ). Les poids des concentrations en oxydes sont donnés en % et les concentrations en éléments en ppm ; SD = écart-type.*

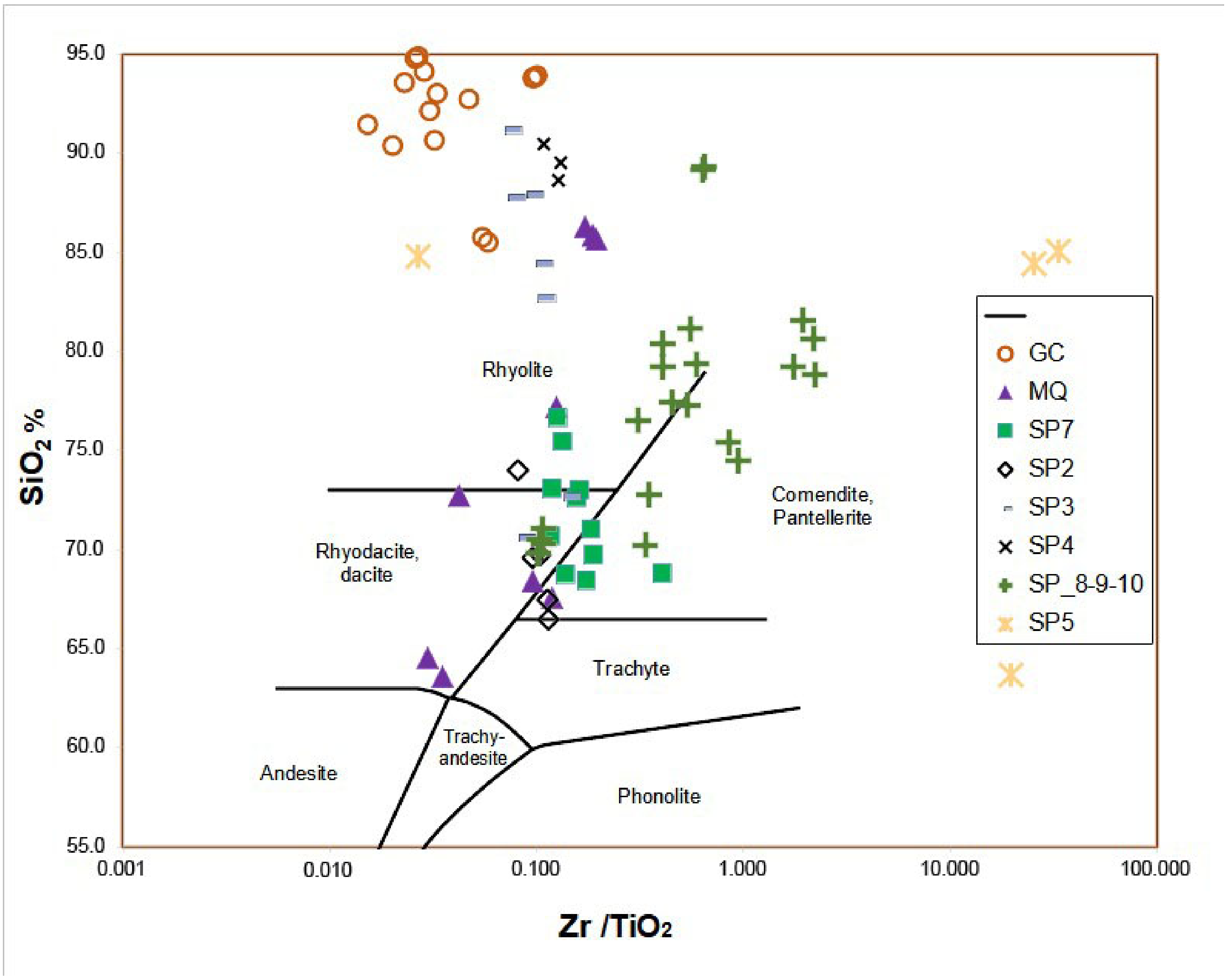


Fig. 20 – SiO2 diagram as a function of the Zr/TiO2 ratio (according to Winchester and Floyd, 1977; M. Guiavarc'h).
***Fig. 20** – Diagramme de SiO2 en fonction du rapport Zr/TiO2 (selon Winchester et Floyd, 1977 ; M. Guiavarc'h).*

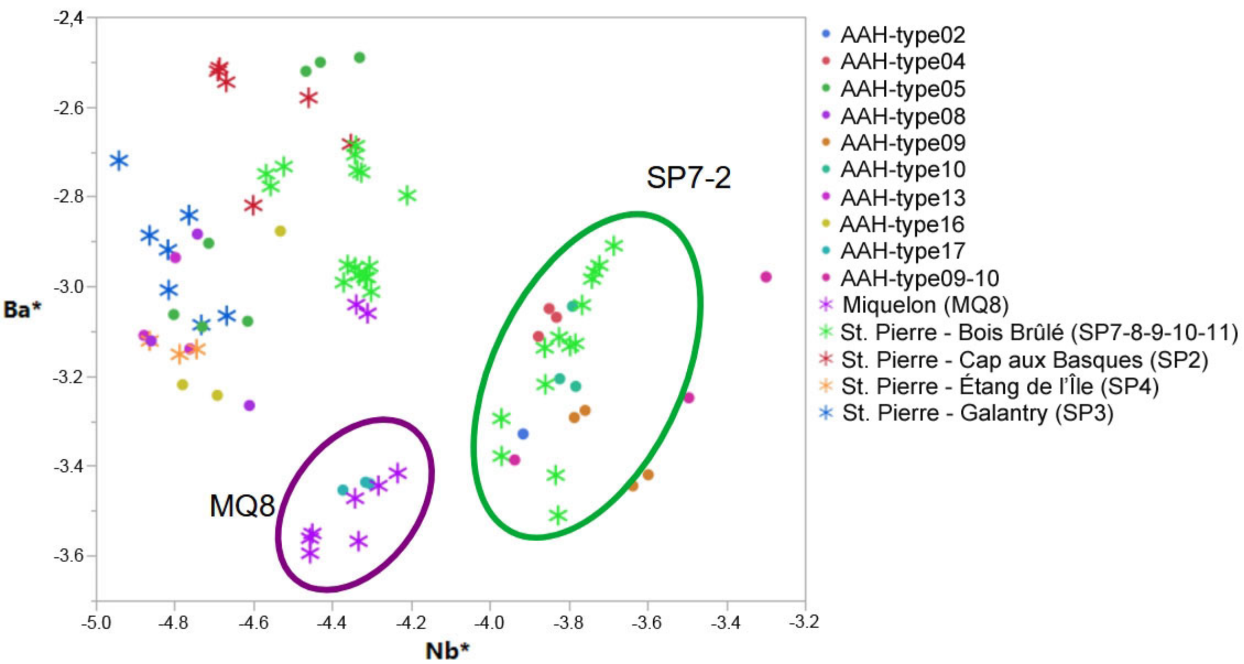


Fig. 21 – Bivariate graph comparing the Ba and Nb contents of rocks from the deposits and worked rocks from the Anse-à-Henry site. The stars correspond to the geological samples of the deposits, while the dots indicate the analysed artefacts.
***Fig. 21** – Graphique bivarié comparant les teneurs en Ba et Nb des roches des gisements et des roches exploitées du site de l'Anse-à-Henry. Les étoiles correspondent aux échantillons géologiques des gisements, tandis que les points signalent les artefacts analysés.*

rock has the same composition as the material from SP-4. The chemical analyses did not link type 15 to any quarry in St. Pierre and Miquelon. This rock type is probably not a rhyolite. The analyses also showed that the SP-5 quarry at Cap Rouge was not present in the Anse-à-Henry collection.

The research to determine the origin of the rocks used at the Anse-à-Henry site and the diffusion of the rocks from the St. Pierre and Miquelon quarries is in its very early stages. Petrographic characterisation of all these facies is imperative to guide our geochemical analyses. To refine the models for determining the origins of the rocks, it is also essential for statistical purposes to increase the number of reference samples. At least 30 samples should be analysed for each facies from a deposit. This will improve the assessment of the chemical variability of the rocks and refine the provenance models. Another important methodological consideration is the impact on chemical composition of rock alteration states and patinas on archaeological and geological objects. Finally, the use of more precise additional analytical techniques such as LA-ICP-MS will provide a more accurate evaluation of the geochemical methods.

5.4. How are raw materials circulating?

Identifying deposits and determining rocks is not sufficient to fully characterise the transfer networks of lithic materials. It is also essential to analyse the forms in which the materials were introduced into the sites (as raw or hewn boulders, raw materials or finished products). This information will provide an understanding of the ways in which resources were acquired and managed while considering the impact of the geological and geomorphological environment on the human groups' technical and economic choices. The stratigraphic complexity evident at the end of our first campaign is likely to complicate this project, because we will be looking at an average overall picture agglomerating at least 2,500 years of diverse practices. However, there is a clear diversity of supplies at the spatial level at the Anse-à-Henry site. Homogeneous glossy grey chert accounts for 41.8% of the pieces in the assemblages collected in September 2019. In the absence of sedimentary silicates on the St. Pierre and Miquelon archipelago, our predecessors have proposed comparisons with deposits found in Newfoundland, notably those on the west coast at Cow Head, situated approximately 350 km away as the crow flies (LeBlanc and Rabottin, 2005, p. 46). The debitage from the Factory Cove site, which was exploited for raw materials by the Groswater phase Paleo-Inuit hunters, includes unfinished objects and preforms (36% of the total collection) as well as 87,006 flakes recovered from a surface area of 160 m^2 (Auger, 1984, p. 62).

We are now able to affirm that some of the objects found at Anse-à-Henry were made on-site, as evidenced by the number of flakes and shaping splinters uncovered in test pit D (structure 6). The rhyolite from Grand Colombier represents the second largest volume of pieces in the 2019 corpus, accounting for 31.9%, but it was almost exclusively identified at test pit H, situated on the slope, and was almost totally absent from the test pits located in the low-lying area (north zone). As for the ignimbritic rhyolites, the *chaînes opératoires* (reduction sequences) identified at this site were almost exclusively oriented towards the production of bifacial pieces. Cutting activities are indeed only just visible in the very rare lithic core fragments and the flakes from striking platforms. The production process was sometimes initiated by direct percussion on the hard stone or during the cutting process to correct errors. The shaping was then done by direct gentle percussion, with a preparation of the striking platforms (removal of the overhang or even extensive grinding and sometimes faceting of the heel).

CONCLUSION

In the context of a strongly expressed social and political will (for the archaeological documentation of the maritime activities of an archipelago over a long period of time), the archaeological project described in this article has presented a variety of analyses and results. The processing of the LiDAR images immediately revealed the density of the historic settlements but provides no data as to the more discrete prehistoric habitats. These renewed excavations at Anse-à-Henry focused on the link between geomorphology and archaeology to consider the multitude of erosive processes that affect the archaeological signal had previously been overlooked. This ongoing interdisciplinary dialogue forms the basis for recommendations concerning the preservation of the archaeological heritage.

At the level of the Anse-à-Henry site, this approach has already led to an adjustment of some of the findings from the research carried out on the slope in the 2000s. On the other hand, the low-lying area of the site, near Rocher de La Vierge, has yielded a remarkably structured archaeological level attributable to the Groswater phase. The size of this site and the quantity of lithic remains it contains indicate that it was a node in what were probably very diverse economic and social networks, which must be characterised. The approach used here combines geoarchaeology and petroarchaeology and is based on intensive field prospections throughout the archipelago. This makes it possible to connect points in space, habitats and quarries. These will eventually need to be supplemented with evidence of tool use or the nature of habitat structures. By determining activity facies, we will then be able to provide a clearer picture of maritime mobility practices and thus better understand the connectivity of these networks.

REFERENCES

Aitchison J., Greenacre M. (2002) – Biplots of Compositional Data, *Journal of the Royal Statistical Society Series C* (Applied Statistics), 51, 4, p. 375-392.

Aubert De La Rüe E. (1937) – Le territoire de Saint-Pierre-et-Miquelon. Étude de géographie physique et humaine, *Journal de la Société des américanistes*, 29, 2, p. 239-372.

Aubert De La Rüe E. (1944) – *Saint-Pierre-et-Miquelon,* Montréal, éd. L'Arbre (France Forever), 111 p.

Aubert De La Rüe E. (1951) – *Recherche géologiques et minières aux îles de Saint-Pierre et Miquelon*, Office de la recherche scientifique outre-mer, Paris, librairie Larose, 88 p.

Auger R. (1984) – *Factory Cove: Recognition and Definition of the Early Palaeo-Eskimo Period in Newfoundland*, master's dissertation, Memorial University of Newfoundland, St. John's, 184 p.

Auger R., Marchand G, Rousseau L., Naud A., Le Doaré M., Quesnel L., Stéphan P. (2019) – *Le site de l'Anse-à-Henry, Saint-Pierre, Saint-Pierre-et-Miquelon*, rapport final d'opération de fouille programmée, DRAC-SRA de Bretagne, CNRS UMR 6566 CREAAH, Rennes, 169 p.

Auger R., Marchand G., Le Doaré M. (2020) – *Prospection inventaire de l'archipel Saint-Pierre-et-Miquelon 2019*, rapport de prospection inventaire, DRAC-SRA de Bretagne, Rennes, 80 p.

Ballantyne C. K. (2001) – Measurement and Theory of Ploughing Boulder Movement, *Permafrost and Periglacial Processes*, 12, 3, p. 267-288.

Betts M. W., Hrynick M. G. (2021) – *The Archaeology of the Atlantic Northeast*, Toronto, University of Toronto Press, 408 p.

Billy J. (2014) – *Morphologie et architecture d'une barrière composite paraglaciaire : l'isthme de Miquelon-Langlade (N-O Atlantique)*, doctoral thesis, université de Perpignan Via Domitia, Perpignan, 322 p.

Bird Life International (2021) – *Important Bird Areas factsheet: Grand Colombier Island*, http://www.birdlife.org

Blein O., Rabu D., Courbouleix S., Audru J.-C. (2015) – *Notice explicative, carte géologique de France (1/50 000), feuille de Saint-Pierre-et-Miquelon*, Orléans, BRGM, 154 p.

Erwin J. (2003) – A Groswater Palaeoeskimo Feature from Coachman's Cove, Newfoundland, *Études/Inuit/Studies*, 27, 1-2, p. 435-449.

Fitzhugh W. (1972) – *Environmental Archaeology and Cultural Systems in Hamilton Inlet, Labrador*, Washington, Smithsonian Institution Press (Contributions to Anthropology, 16), 299 p.

Gauvain D. (1916) – *Almanach du centenaire (1816-1916)*, Paris, C. Renaudie, 80 p.

Hood B. C. (1993) – The Maritime Archaic Indians of Labrador: Investigating Prehistoric Social Organisation, *Newfoundland Studies*, 9, 2, p. 163-184.

La Roche-Poncié J. de (1841) – *Carte des îles Saint-Pierre et Miquelon*, Archives nationales des outre-mer. http://anom.archivesnationales.culture.gouv.fr/ulysse/osd?id=fr_anom_05dfc168b&id=fr_anom_05dfc168b

Lavers D., Renouf M. A. P. (2012) – A Groswater Palaeoeskimo Component at the Dorset Palaeoeskimo Phillip's Garden Site, Port au Choix, Northwestern Newfoundland, *Canadian Journal of Archaeology*, 36, p. 311-336.

Lebailly A. (2015) – *Saint-Pierre-et-Miquelon. Histoire de l'archipel et de sa population*, Saint-Pierre-et-Miquelon, éditions Jean-Jacques Oliviéro, 200 p.

LeBlanc S. (2000) – Groswater Technological Organization: A Decision-Making Approach, *Arctic Anthropology*, 37, 2, p. 23-37.

LeBlanc S. (2008) – *Middle Dorset Variability and Regional Cultural Traditions: A Case Study from Newfoundland and St. Pierre and Miquelon*, PhD thesis, University of Alberta, Edmonton, 231 p.

LeBlanc S., Rabottin J.-L. (2000) – *Cinq mille ans d'occupation à l'Anse-à-Henry*, rapport d'étape. Phase 1 : mission de reconnaissance, Collectivité territoriale / Musée de l'Arche, St. Pierre and Miquelon, 42 p.

LeBlanc S., Rabottin J.-L. (2003) – *Un campement indien récent à l'Anse-à-Henry*, rapport d'activités, mission archéologique 2002, Collectivité territoriale / Musée de l'Arche, St. Pierre and Miquelon, 100 p.

LeBlanc S., Rabottin J.-L. (2005) – *Anse-à-Henry, aire de fouille 2003-2004*, rapport d'activités, mission d'archéologie 2004, Collectivité territoriale / Musée de l'Arche, St. Pierre and Miquelon, 92 p.

LeBlanc S., De Lizaraga R., Rabottin J.-L. (2001) – *Archéologie, Anse-à-Henry, 5000 ans d'histoire*, Saint-Pierre-et-Miquelon, L'Arche, 18 p.

Leck A., Le Bourdonnec F.-X., Gratuze B., Dubernet S., Ameziane-Federzoni N., Bressy-Leandri C., Chapoulie R., Mazet S., Bontempi J.-M., Marini N., Remicourt M., Perrin T. (2018) – Provenance d'artefacts en rhyolite corse : évaluation des méthodes d'analyse géochimique, *Comptes rendus Palevol*, 17, 3, p. 220-232.

Le Doaré M. (2018) – *Rapport de prospection archéologique. Prospection diachronique par télédétection par LiDAR de l'archipel de Saint-Pierre-et-Miquelon,* DRAC-SRA de Bretagne, CNRS UMR 6566 CREAAH, Rennes, 312 p.

Linnamae U. (1975) – *The Dorset Culture. A Comparative Study in Newfoundland and the Arctic*, St. John's, Dept. of Tourism, Historic Resources Division (Technical Papers of the Newfoundland Museum, 1), 264 p.

Losier C., Livingston M., Tapper B. (2016) – *Rapport de prospection archéologique 2016, Saint-Pierre-et-Miquelon*, Saint-John's, Memorial University of Newfoundland, 65 p.

Marchand G., Auger R., Rousseau L., Le Doaré M., Stéphan P. (2020) – Préhistoire de l'archipel de Saint-Pierre-et-Miquelon : les occupations humaines de l'Anse-à-Henry à l'épreuve de l'érosion littorale, *Bulletin de la Société préhistorique française,* 117, 2, p. 148-151.

Marchand G., Borthaire C. (2020) – *Préhistoire de l'archipel de Saint-Pierre et Miquelon*, Rennes, CNRS-Université de Rennes 1, 72 p.

Mclean L. (1994) – Back to the Beaches: New Data Pertaining to the Early Beothuk in Newfoundland, *Northeast Anthropology*, 47, p. 71-86.

Rabu D., Thiéblemont D., Tegyey M., Guerrot C., Alsac C., Chauvel J.-J., Murphy J. B., Keppie J. D. (1996) – Late Proterozoic to Paleozoic Evolution of the St. Pierre and Miquelon Islands: A New Piece in the Avalonian Puzzle of the Canadian Appalachians, in D.R. Nance and M.D. Thompson (eds.), *Avalonian and Related Peri-Gondwanan Terranes of the Circum-North Atlantic*, Boulder, Geological Society of America, (Special Paper, 304), p. 65-94.

Reimer P., Austin W., Bard E., Bayliss A., Blackwell P., Bronk Ramsey C., Butzin M., Cheng H., Edwards R., Friedrich M., Grootes P., Guilderson T., Hajdas I., Heaton T., Hogg A., Hughen K., Kromer B., Manning S., Muscheler R., Palmer J., Pearson C., Van Der Plicht J., Reimer R., Richards D., Scott E., Southon J., Turney C., Wacker L., Adolphi F., Büntgen U., Capano M., Fahrni S., Fogtmann-Schulz A., Friedrich R., Köhler P., Kudsk S., Miyake F., Olsen J., Reinig F., Sakamoto M., Sookdeo A., Talamo S. (2020) – The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0-55 cal kBP), *Radiocarbon*, 62, 725-757, https://doi.org/10.1017/RDC.2020.41

Renouf M. A. P (1993) – Palaeo-Eskimo Seal Hunters at Port au Choix, Northwestern Newfoundland, *Newfoundland and Labrador Studies*, 9, 2, p. 185-212.

Renouf M. A. P (1999) – Prehistory of Newfoundland Hunter-Gatherers: Extinctions or Adaptations?, *World Archaeology (Arctic Archaeology)*, 30, 3, p. 403-420.

Renouf M. A. P. (2003) – A Review of Pre-Inuit Dwelling Structures in Newfoundland and Labrador, *Études/Inuit/Studies*, 27, 1-2, p. 375-416.

Renouf M. A. P. (2005) – Phillip's Garden West: A Newfoundland Groswater Variant, in P. Sutherland and Q.C. Hull (eds.), *Contributions to the Study of the Dorset Palaeo-Eskimos*, Gatineau, Canadian Museum of Civilization (Mercury Series, Archaeological Survey of Canada, 167), p. 57-80.

Renouf M. A. P. (2006) – Re-investigating a Middle Phase Dorset Dwelling at Phillip's Garden, Port au Choix, Newfoundland, in J. Arneborg and B. Gronnow (eds.), *Dynamics of Northern Societies*, Proceedings of the SILA/NABO Conference on Arctic and North Atlantic Archaeology (Copenhagen, May 10th-14th 2004), Copenhagen, National Museum (Studies in Archaeology and History, 10), p. 119-128.

Ribault J.-Y. (1962) – *Les îles Saint-Pierre et Miquelon (la vie dans l'archipel des origines à 1814)*, Saint-Pierre, imprimerie du gouvernement, 148 p.

Sasco E. (1931), Expanded By Lehuenen J. (1970 and 1998) – *Chronologie des îles Saint-Pierre et Miquelon d'après les Éphémérides des Îles Saint-Pierre et Miquelon*. http://www.le-hors.org/EphemeridesSPM.htm

Schmidt P. (1983) – Découverte d'un site amérindien à la Pointe à Henry, île Saint-Pierre, Saint-Pierre-et-Miquelon, *Bulletin de la Société préhistorique française* (Actualité scientifique), 80, 9, p. 266-274.

Tuck J. A. (1971) – An Archaic Cemetery at Port Au Choix, Newfoundland, *American Antiquity*, 36, 3, p. 343-358.

Tuck J. A., Fitzhugh W. W. (1986) – Palaeo-Eskimo Traditions of Newfoundland and Labrador: A Re-Appraisal, in J.A. Tuck and W.W. Fitzhugh (eds.), *Palaeo-Eskimo Cultures in Newfoundland, Labrador, and Ungava*, St. John's, Memorial University of Newfoundland (Reports in Archaeology, 1), p. 161-167.

Tuck J. A., Pastore R. T. (1985) – A Nice Place to Visit, but… Prehistoric Human Extinctions on the Island of Newfoundland, *Canadian Journal of Archaeology (Journal canadien d'archéologie)*, 9,1, p. 69-80.

Winchester J. A., Floyd P. A. (1977) – Geochemical Discrimination of Different Magma Series and their Differentiation Products Using Immobile Elements, *Chemical Geology*, 20, p. 325-343, https://doi.org/10.1016/0009-2541(77)90057-2

Grégor Marchand
CNRS UMR 6566 CReAAH
Rennes, France

Réginald Auger
Université Laval
Québec, Canada

Cédric Borthaire
Lycée Émile-Letournel
Saint-Pierre, Saint-Pierre-et-Miquelon

Mikaël Guiavarc'h
CNRS UMR 6566 CReAAH
Rennes, France

Maureen Le Doaré
Société ARCHAÏOS
Paris, France

Lolita Rousseau
INRAP
UMR 6566 CReAAH
Cayenne, France

Pierre Stéphan
CNRS UMR 6554 LETG
Brest, France