Understanding how ancient societies coped with volcanic disasters has contemporary relevance since modern population growth and displacement is pushing many groups into high-risk areas (Sheets 2007; Tobin and Montz 1997: 2). Current disaster managers note that effective planning depends on historical knowledge about the behavior of the volcano and also the strategies that human societies have adopted to cope with volcanic activity, both on the long and short term (e.g., Berger 2006). Volcanically active regions provide intriguing opportunities for using the broad lens of landscape archaeology to study persistence, adaptation, and culture change in the face of natural disasters. This chapter highlights the advantages of studying ancient landscapes in environments where humans have experienced volcanic activity. The archaeological potential offered by buried landscapes, tephrochronology, and the (re)creation of spaces is discussed and then illustrated through a case study that has revealed 40,000 years of human response to relatively frequent volcanic activity.

**Potentials of Volcanic Landscapes**

Many archaeological studies of cultural landscapes focus on the distribution of artifacts, features, art, and monuments across space, but these generally rely on modern surfaces, most of which have had long and complex taphonomic histories. The resulting palimpsests can be very difficult to disentangle in terms of the time scales appropriate for reconstructing change within human societies (e.g., Bradley 2002; Holdaway, Fanning, and Shiner 2005; Wandsnider 1992). In contrast, volcanic activity can freeze the archaeological record at one “moment” in time. The early hominid footprints at Laetoli (Agnew, Demans, and Leakey 1996) and the settlements at Pompeii, Italy (e.g., Allison 2002) or Ceren, El Salvador (Sheets 1992, 2002) are famous examples of the special conditions that have preserved cultural remains intact under volcanic flows and/or airborne ash. Although most studies of the effects of volcanic activity on ancient societies focus on single events such as these, which are usually viewed from the perspective of a single or very few discrete locations (e.g., Allison 2002; see chapters by Driessen and Macdonald, Bicknell, and Plunket and Uruñuela in McGuire, Griffiths, and Stewart 2000; Manning and Sewell 2002; Shimoyama 2002), broadening the spatial and temporal scales of the studies significantly enhances our knowledge about human responses to natural disasters.

The volcanic flows that have buried sites such as Ceren or Pompeii are spatially quite restricted. In contrast, highly explosive volcanic eruptions (called plinian) can result in the spread of thick layers of airborne ash (more correctly termed tephra) that extend over very large areas and preserve an extensive, continuous surface measured on the
appropriate scale of a landscape. A combination of field and laboratory-based methods is used to identify and trace the diagnostic volcanic covering layer across large regions (Cronin and Neall 2000; Elson et al. 2007; Lowe, Newnham, and McCraw 2000; Newnham et al. 1998; Sheets 1983; Sheets and McKee 1994; Torrence et al. 2000; Zeidler and Isaacson 2003). The burial event is usually dated by radiocarbon determinations of material trapped in the volcanic tephra or through a comparison of multiple dates from above and below the volcanic layer (e.g., Buck, Higham, and Lowe 2003), although luminescence dating can also be used (e.g., Torrence et al. 2004). The use of such well-dated, tephra marker layers has enabled scholars to track contemporary patterns of human settlement across large regions (e.g., Cordova, Martin del Pozzo, and Camacho 1994; Cronin and Neall 2000; Elson et al. 2002; Lowe et al. 2002; Machida and Sugiyama 2002; Santley et al. 2000; Sheets 1979, 1983; Sheets and McKee 1994; Torrence et al. 2000; Zeidler and Isaacson 2003; Zeidler and Pearsall 1994).

Reconstruction of cultural landscapes before and after volcanic events enables comparison of how the same geographical "space" was recreated as a social "place," especially if people were forced to flee the region and decolonize later. Since the creation of cultural landscapes from virgin territory is a rare occurrence, comparative studies of old places imbued with memory versus spaces colonized anew following a volcanic event could provide important insights about how cultural landscapes are shaped. Within highly active volcanic areas, eruptions occur relatively frequently. The resulting stratified series of buried ground surfaces dating to different periods provides an intriguing opportunity to study the history of cultural constructions of landscape within a single geographic setting.

The way memory is used within unstable volcanic environments may be different from that in other areas because places and features are frequently altered, obliterated, or buried and are therefore relatively short-lived. Rather than build on and/or reuse older elements of the natural and built environments, people who colonize or return to areas altered by volcanic activity must rework their transported concepts of place within an unfamiliar

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**Figure 34.1** Archaeological study areas at Garua Island and the Isthmus region in the Willaumez Peninsula,
setting. In contrast, the memory of the disaster can be a powerful element in the construction of cultural landscapes. Volcanoes themselves together with their eruptive products, such as bombs, pumice, and obsidian, may provide potent symbols or become elements of cosmology or religious beliefs, and these are often reflected in the location and the content of rock art and shrines, as well as meanings assigned to volcanic materials (e.g., Allison 2002; Blong 1982; Chester and Duncan 2007; Cronin and Cashman 2007; Dillian 2004, 2007; Elson et al. 2002; Hoffman 1999: 306; Holmberg 2007; Plunket and Uruñuela 1998a, 1998b).

A series of buried landscapes facilitates a comparative perspective that can address significant questions about the effects of natural disasters on human societies (cf. Hoffman 1999). Archaeologists have begun investigating the vulnerability or resilience of societies organized in different ways, the potential effects of differing levels of severity of volcanic event on the nature of culture change, and how cultural landscapes have been (re)colonized, (re)conceived, and (re)constructed after differing degrees of environmental destruction and change. Excellent studies of buried cultural landscapes have been conducted in Central America (e.g., Sheets 1994, 1999, 2007; Sheets et al. 1991; Siebe et al. 1996), South America (Zeidler and Isaacs 2003), Japan (Machida 1984; Shimoyama 2002), and Papua New Guinea (Pavlides 1993, 2004, 2006; Torrence 2002a, 2002b; Torrence and Doelman 2007; Torrence et al. 2000).

A Case Study

Current archaeological research in the Willaumez Peninsula region of New Britain, Papua New Guinea, illustrates how a series of well-dated, short-lived, buried surfaces can facilitate the study of cultural landscapes (Figure 34.1). Throughout the entire period of human history here (ca. 45,000 years), the region has experienced a series of volcanic eruptions, each of which has repeatedly preserved areas at the scale of tens of thousands of square kilometers underneath a thick blanket of airfall tephra. These marker layers are visually and chemically distinctive and temporally secure, and so individual ancient ground surfaces can be traced across the Willaumez Peninsula and beyond (Machida et al. 1996; Pavlides 1993, 2004; Torrence et al. 2000) (Figure 34.2). Since many of these volcanic disasters forced abandonment for periods ranging from several to tens of generations, the resulting punctuated history of occupation can be viewed from the perspective of abandonment (Figure 34.3). Despite these catastrophic interruptions, the flaked stone tool industry persisted unchanged. It is therefore possible to hypothesize that the various late Pleistocene colonizers may have used the region, and perhaps even conceived of it, in similar ways.

During the most recent 6,000 years, humans experienced four very severe volcanic eruptions from the Witori volcano (named W-K1, W-K2, W-K3, and W-K4) and one major event from Dakataua (named Dk), as well as a host of smaller, localized events (Figures 34.1 and 34.2). The timing of the eruptions has been pinpointed as closely as possible using a Bayesian analysis of radiocarbon dates from within tephras and cultural deposits that bracket them (Petrie and Torrence 2008) (Table 34.1). Given the explosive nature of these five eruptions, the enormous volume of material they produced, and the spatial scale of their impacts (Boyd, Lentfer, and Luker 1999; Machida et al. 1996), there can be no doubt that each generated a disaster resulting in wide scale disruption of human populations and potentially large fatalities. For example, the depth of tephras in the study region indicates that immediately following the event the dusty air would have been dangerous to breathe, and virtually all the vegetation would have been destroyed. Geomorphological studies have also shown that the coastline was modified, particularly after W-K2 (Boyd, Lentfer, and Parr 2005) (cf. A and B in Figure 34.4).

Table 34.1 Calibrated dates (B.P.) at two standard deviations for volcanic eruptions in the Willaumez Peninsula. Based on a Bayesian analysis of radiocarbon dates by Petrie and Torrence (2008).

<table>
<thead>
<tr>
<th>Tephra</th>
<th>Date (B.P.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W-K4</td>
<td>1310–1170</td>
</tr>
<tr>
<td>Dk</td>
<td>1350–1270</td>
</tr>
<tr>
<td>W-K3</td>
<td>1740–1540</td>
</tr>
<tr>
<td>W-K2</td>
<td>3480–3160</td>
</tr>
<tr>
<td>W-K1</td>
<td>6160–5740</td>
</tr>
</tbody>
</table>
Figure 34.2 The stratigraphy within this test pit in the Willaumez Peninsula, Papua New Guinea, comprises a series of landscapes (dark layers), each of which has been buried by a volcanic tephra (light layers). Since each of the tephras has a very distinctive color and texture, they all act as diagnostic chronometric units over a large region.

Figure 34.3 Fire-cracked cooking stones and obsidian artifacts are preserved between layers of volcanic tephra at Kupona na Dari.
Based on an analysis of radiocarbon dates taken from 126 test pits spread across the two study areas on Garua Island (Torrence 2002a; Torrence and Stevenson 2000) and the Isthmus region of the Willaumez Peninsula (Torrence 2002b, 2004a; Torrence and Doelman 2007), the immediate human reaction to all the volcanic disasters appears to have been abandonment. Whether large numbers of people perished in place or found refuge elsewhere is not known, since there has not been adequate research to look for rapid changes in the surrounding regions, although Lilley (2004a, 2004b) has possibly identified an influx of people in the Siassi Islands to the west following the W-K3 eruption. These volcanic events provide opportunities to compare and to contrast how the societies

Figure 34.4 Changes in distribution patterns of obsidian artifacts recovered from 1-meter-square test pits in the Isthmus region of the Willaumez Peninsula. The size of the dots reflects the number of obsidian artifacts recovered from a test pit; (A) post-W-K1, (B) post-W-K2, (C) post-W-K3, (D) post-W-K4, (E) most recent 500 years.
(re)created cultural landscapes within devastated environments.

**Dating**

Radiocarbon dating cannot pinpoint the exact date when people returned after each disaster, but some interesting patterns can be identified from the Bayesian analysis (Petrie and Torrence 2008). Given that tropical forests decimated by similar volcanic events with comparable tephra thicknesses have been witnessed to regenerate in less than 100 years (Lentfer and Boyd 2001; Thornton 1997), the estimated periods for abandonment (Table 34.2), are surprisingly long, particularly after W-K1. The character and the rate of (re)colonization after each of the volcanic disasters differ. Following the W-K1 event, there is a long gap in time with no evidence of occupation. Through time, the number of places with evidence for human presence increases slowly and erratically. This pattern suggests that small groups moved in sporadically at first and that the population increased gradually. In contrast, after W-K2, which was a larger eruption, a relatively large number of places were first colonized almost simultaneously. This pattern would be consistent with the sudden arrival of a relatively large population. The even greater population that returned to the Isthmus region immediately following the Dk event, together with a large gap in time on Garua Island, suggests the arrivals of refugees who had fled the more seriously affected region near the volcano. With the exception of the very disastrous Dk eruption on Garua, the speed of recolonization increased through time. Part of the explanation for the changes in the character of recolonization is due to the particular character of the different events, including variations in tephra depths, subsequent modifications through coastal change, and patterns of tephra erosion, but some of the variation is also likely to result from cultural adaptation to disasters, population growth, and cultural conceptions regarding previous “homelands” or “unexplored” areas.

**Artifact Assemblages**

Changes in the character and the composition of artifact assemblages could indicate that a different cultural group moved into the area following a gap in settlement after the volcanic disaster (Sheets 2007; cf. Sheets et al. 1991). Following the W-K1 event, the reappearance of large retouched obsidian artifacts, which are identical to those made before the eruption (Araho et al. 2002), suggests the same cultural group had survived somewhere else, continued the same cultural tradition of making these artifacts, and then eventually recolonized the area. After W-K2, these artifacts disappeared, and highly decorated Lapita pottery arrived as part of a much wider, regional cultural change and reorganization of landscape. Whether these pottery makers represent the arrival of a new cultural group to this area or the introduced pottery simply indicates change within the previously established group is the subject of intense debate (cf. Lilley 2004b). Interestingly, the subsequent disappearance of pottery in this region is probably not related to volcanic activity. Artifact assemblages do not alter after later events (cf. Torrence 2002a, 2002b).

Patterns of land-use can be inferred from the spatial distribution of obsidian artifacts recovered from the test pits (Figures 34.4 and 34.5) together with studies of plant microfossils (Boyd, Lentfer, and Parr 2005; Lentfer and Torrence 2007). The spatial distribution of artifacts from both study regions demonstrates that the inland areas, which have normally been under-researched by Pacific archaeologists, were consistently used throughout prehistory. In a preliminary analysis of the distributional data, it was shown that there was a steady change through time in the distribution of obsidian artifacts on Garua Island. Following a homogeneous spread of material across the island, there was a shift to a more clustered pattern in which most of the material was discarded in fewer places. A similar process can be identified for the Isthmus region, although it is not so pronounced. This trend has been interpreted as the consequence of a gradual shift toward reduced mobility that was associated with an increase in the intensification of land use (Torrence 2002a; Lentfer and Boyd 2001).

**Table 34.2** Length of abandonment (calendar years) in the two study areas following volcanic eruptions; based on a Bayesian analysis of radiocarbon dates at two standard deviations by Petrie and Torrence (2008).

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Garua</td>
</tr>
<tr>
<td>Post-W-K4</td>
<td>0–170</td>
</tr>
<tr>
<td>Post-Dk</td>
<td>0–260</td>
</tr>
<tr>
<td>Post-W-K3</td>
<td>0–270</td>
</tr>
<tr>
<td>Post-W-K2</td>
<td>0–300</td>
</tr>
<tr>
<td>Post-W-K1</td>
<td>0–260</td>
</tr>
</tbody>
</table>
It is also important to track the relationship between major environmental changes due to volcanic activity and land use. In the Isthmus area (Figure 34.4), a large tidal embayment was overwhelmed by massive flooding of volcanic debris following the W-K2 eruption. Despite the conversion of the surrounding area from coastal to inland floodplain/swamp, the same specific locations were reoccupied, possibly reflecting memory. In contrast, on Garua Island there are shifts in the distribution of artifacts between the coast and inland between different periods. In what ways the variations between the two study areas are due to local environmental differences, to land-use patterns, or relate to cultural concepts represent an important topic for continuing research.

### Social Networks and Exchange

Exchange networks appear to have been an integral part of social life in the Willaumez Peninsula (e.g., Torrence et al. 1996; Torrence and Summerhayes 1997). Social links can be inferred from the wide-scale movement of obsidian and the presence at many localities of material derived from multiple sources. Changes in obsidian distribution are partially tied to the effects of volcanic activity, but the role of social processes can also be inferred (Torrence 2004a; Torrence et al. 2004). Volcanic activity restricted the physical access to the sources. The Mopir obsidian source, situated close to Witori, was put out of action by the W-K2 eruption, which cut off its access by sea and buried the surrounding region under tens of meters of pyroclastic flows and airfall tephras. In contrast, following the Dk event when the region surrounding the other sources was

Turning to social and cultural factors in the use of obsidian, we see the Kutau source was obviously highly valued, because it was continually used on Garua, although the island has its own local obsidian. The consumption of obsidian imported to the island demonstrates that proximity to a resource was a less important factor in raw material choice than were the social relations forged by exchange. In fact, after the W-K2 eruption, there is a change from the widespread use of multiple sources to a situation in which Kutau dominated the obsidian assemblages in both Garua and the Isthmus region. This pattern suggests that special meaning may have been assigned to the Kutau obsidian outcrops themselves or possibly to the people who owned and exchanged this material. After W-K4, obsidian source use broadened out again to include all the sources, signaling yet another shift in the meaning and the role of the sources, their owners, and/or exchange relationships.

### Conceptions of Landscapes

Although environmental and demographic variables must have played an important role in shaping the punctuated history of settlement of the region (Torrence and Doelman 2007), for colonization to take place, people require appropriate concepts of the new lands: for example, as extensions of their homelands, as empty, or as a new opportunity. The devastated area may not have been conceived as an empty space but as a culturally meaningful place that was physically and/or spiritually “dangerous” because of the volcanic activity, as is the case for volcanically active areas in many Pacific Islands today (Cronin and Cashman 2007; Lowe et
Conclusions

As illustrated in this brief summary of ongoing research in the Willaumez Peninsula, well-preserved, buried archaeological contexts characteristic of volcanically active regions provide unique windows into the past. Opening the “window” as far as possible to view human interactions with their environment and the creation of cultural landscapes across large areas and through long punctuated sequences may yield a rich understanding of conceptions and constructions of place. The advantages of volcanic settings, however, come with a cost. Reconstructing the severity and the character of the volcanic disasters people faced, as well as ancient environments before and after volcanic activity, and tracking their physical recovery demand rigorous interdisciplinary research (e.g., Boyd, Lentfer, and Parr 2005; Sheets 1983; Sheets and McKee 1994; Zeidler and Pearsall 1994). Intensive, systematic fieldwork is also required to locate, study, and date an adequate sample of the often deeply buried archaeological material. Despite such demands, the growing number of studies in volcanic environments show that when these challenges are met, archaeology among the volcanoes can make a significant contribution to our understanding of cultural landscapes.

Acknowledgments

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References


Chapter 34: Punctuated Landscapes


Chapter 34: Punctuated Landscapes


