How far to Conchucos? A GIS approach to assessing the implications of exotic materials at Chavín de Huántar

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Abstract

Chavín de Huántar has long been recognized as a site of pan-regional importance in the first millennium BCE Central Andes. Multiple lines of evidence link the site to *costa*, *sierra* and *selva*. Using exotic goods for which provenance is known – for example, obsidian, cinnabar, selected ceramics and marine shell – specific areas with which Chavín interacted can be identified. These interactions are considered in the context of distinct ways of thinking about Central Andean space – a least-cost transportation surface, the Inca road network and ethno-historically reconstructed territories. I argue that explicitly modeling the implications of connecting such nodes and considering distance in multiple ways facilitates a better characterization of interregional interaction.

Keywords

Least-cost paths; Chavín; interaction networks.

Introduction

The first millennium BCE ceremonial center of Chavín de Huántar, iconic in Andean archaeology for its monumental architecture and elaborate lithic art, has long been linked to far-flung areas of the Central Andes (Fig. 1). These include sites connected by similarities in material culture and/or architecture and sources of raw material, and have played an important role in interpretations both of Chavín itself and of regional developments in the Central Andes during this period (see, for example, Burger 1988, 1993, 2008; Kembel and Rick 2004; Lumbreras 1989; Rowe 1962). Indeed, attention to the first millennium BCE in Peru stems from the apparent burgeoning of interregional interaction and the relationship of that activity to increasing sociopolitical differentiation and material elaboration at a variety of sites.

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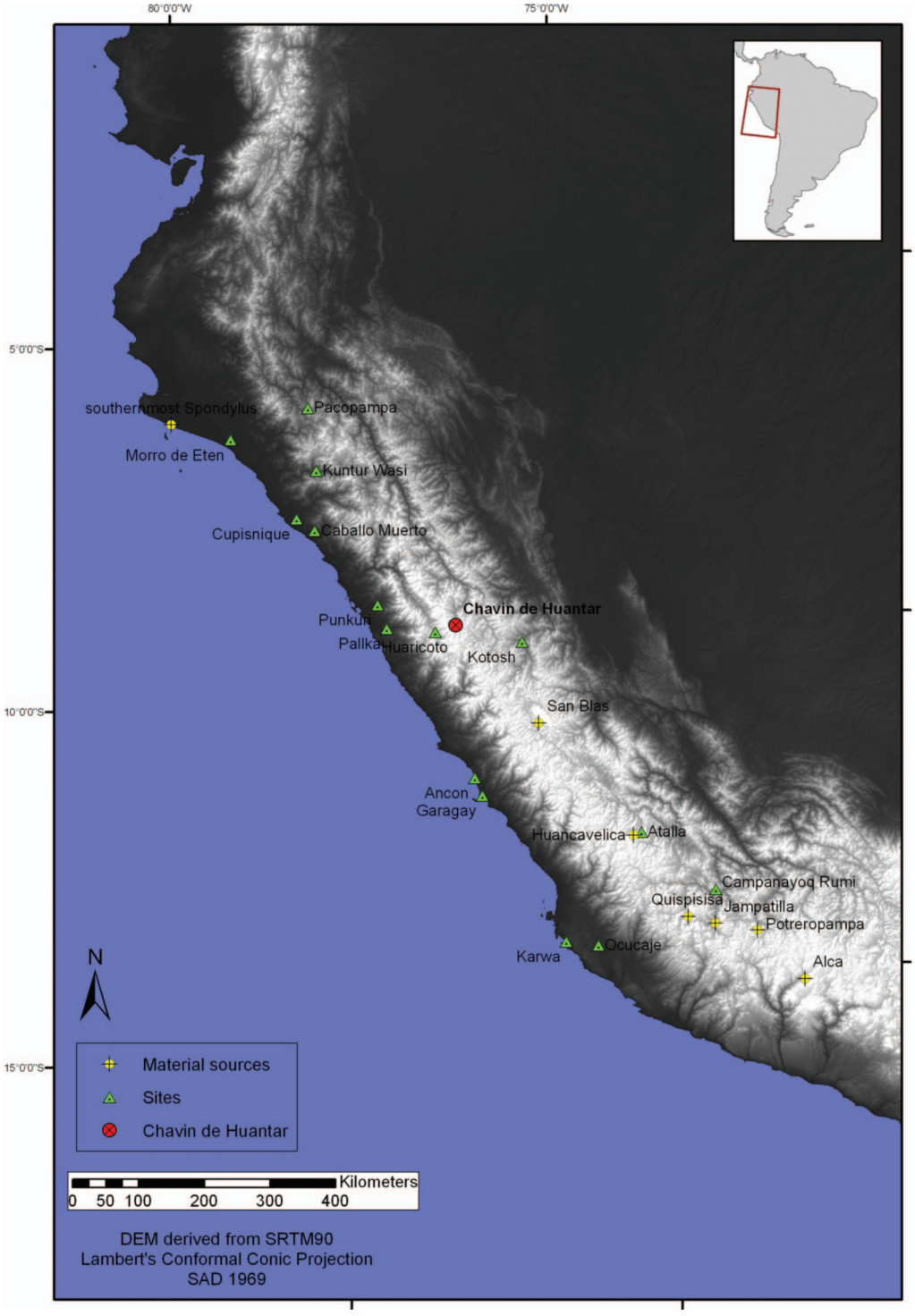

Figure 1 Chavín's interaction network.

While the hunt for evidence linking Chavín to other sites has been one of the exciting concerns of Central Andean archaeology for a century, characterization of interaction has remained challenging. The principal means of recognizing interaction remains the identification of exotic materials and, while the tools for such identification have been bolstered by the addition of methods of geochemical sourcing that provide robust provenance data, stylistic and iconographic affinities in both architecture and portable material culture continue to be fundamental. The challenge of moving beyond placing points on maps, drawing lines between sites, and/or constructing inclusive territorial entities ('interaction spheres', 'trade networks', 'empires', etc.) remains. This paper explores methods of constructing and interpreting node-and-network maps of interaction, using exotic materials and iconographic links to other sites documented at Chavín de Huántar as a case study.

Interregional interaction and Chavín de Huántar

Formal, archaeological attention to Chavín began with Julio C. Tello, who not only excavated at the site but also called attention to Chavín's apparent links with other parts of Peru. He specifically noted that the style of lithic art evident at Chavín had echoes throughout much of Peru in a variety of media and thus tied together widely scattered sites into what he termed the 'Chavín megalithic culture' (Tello 1943), a concept which has persisted. Gordon Willey (1951) rejected as too broad the criteria Tello used to affiliate sites with Chavín, but accepted the notion of linkage itself. Similarly, John Rowe's (1962) proposal of an 'Early Horizon' – a period of heightened interregional interaction – was defined by the diffusion of stylistic elements related to those found at Chavín.

Subsequent research at Chavín more thoroughly characterized the features that tied Chavín to other sites. In conjunction with research at many of those sites, this led to debate regarding the nature of Chavín's relationship to sites with which it shared stylistic affinities (e.g. Burger 1988, 1992, 1993, 2008; Kembel and Rick 2004; Lumbreras 1971, 1989, 1993; Rick et al. 2011). These studies commonly examined exotic iconography, architecture, and/or material culture. At Chavín itself, studies of material culture have included ceramics (Lumbreras 1993; Lumbreras et al. 2003; Druc 2004), obsidian (Burger 1984; Contreras and Nado in press; Nado 2007), and marine shell (primarily but not exclusively *Spondylus princeps* and *Strombus galeatus*; see Sayre 2010; Sayre and Lopez Aldave 2009; van Valkenburgh 2003). Iconography has been interpreted as linking Chavín to a wide array of sites both in the highlands and on the coast (see Fig. 1 for a selection of these sites), and inspired Lathrap (1971) to posit more general links to the eastern jungle. Non-local gold, cinnabar and marine mammal bone have also been recovered, and a few Chavín-period sites have been interpreted as specializing in the exploitation of particular raw materials (e.g. Atalla (cinnabar: Burger and Matos Mendieta 2002), Campanayoq Rumi (obsidian: Matsumoto and Cavero Palomino 2010), and San Blas (salt: Morales Chocano 1998a)). Iconographic and architectural evidence has also tied sites throughout Peru to Chavín, notably Kuntur Wasi (Onuki 1995; Carrion Cachot 1948), Pacopampa (Morales Chocano 1998b) and Karwa (Cordy-Collins 1976).

The nature of these links, and of regional interaction in the period, has been a research focus since Tello's time. The absence of iconographic, architectural or material culture evidence of organized violence has led to broad agreement that militarily based territorial control was not behind this regional coherence; rather, recent treatments have focused on interacting peer polities (e.g. Burger 2008; Kembel and Rick 2004). At the same time, as Moore points out, there is 'a consensus rare among Andean archaeologists. . .and even among scholars of different theoretical stripes. . .that Chavín was principally the seat of religious power' (2005: 56). Chavín may thus have been both a node in a network of economic exchange and a focus of pilgrimage involving the offering of exotic materials. Moreover, there is an extensive literature devoted to the role of exotic goods in creating, maintaining and legitimating status differences and sociopolitical authority (e.g., in Andean contexts, Goldstein 2000; Tripcevich 2010).

The focus in this paper is on exotic material culture at Chavín, incorporating linkages to select sites tied to Chavín by stylistic and/or iconographic evidence in order to capture the geographic extent of the network. The principal exotic materials employed in this analysis are discussed below, and summarized in Table 1. Other exotic materials – most notably gold – are not included either because their point of origin cannot be identified or because they are isolated finds.

Obsidian

Obsidian from four Central Andean sources – Quispisisa, Alca, Potreropampa and Jampatilla – has now been geochemically identified at Chavín (Burger 1984; Nado 2007). Circulation of obsidian in the Central Andes dates back into the Archaic Period and by the second millennium BCE the material was being transported many days' travel from its

Table 1 Select exotic materials at Chavín de Huántar

Material	*Origin*	*References*
Obsidian	Quispisisa; Alca; Potreropampa; Jampatilla	Burger 1984; Glascock et al. 2007; Nado 2007
Cinnabar	Huancavelica (Minas Santa Barbara)	Burger 1988; Petersen 2010
Raku ceramics	Cupisnique	Lumbreras 1993*
Wacheqsa ceramics	Cupisnique	Lumbreras 1993
Puksha ceramics	Cupisnique	Lumbreras 1993
Mosna ceramics	Cajamarca	Lumbreras 1993
Salt	San Blas	Morales Chocano 1998a
Strombus and *Spondylus* shell	Coast of Northern Peru and/or Ecuador	Gorriti-Manchego 2000; Paulsen 1974; van Valkenburgh 2003

Note

*The non-local origins of these (and other) ceramics at Chavín are supported by various analytical techniques (Druc 2004; Lumbreras et al. 2003), but these are not able to link ceramics to any particular sources. The geographic links here are those that Lumbreras posits on stylistic grounds

sources; it is thus not surprising to find Chavín involved in networks of obsidian exchange, although the distances involved are several times those previously traveled.

Cinnabar

Richard Burger (1984: 198) identified cinnabar on a Janabarriu-period earspool excavated at Chavín and it has subsequently been tentatively identified in the recesses of relief sculpture in the Circular Plaza there and in a *Spondylus* shell offering in the center of the Square Plaza (John Rick pers. comm.). Cinnabar has also been identified in elite burials at Kuntur Wasi (Onuki 1995) and is interpreted as a prestige good that circulated in exchange networks of the period. It is presumed to come from the Santa Barbara mine in modern Huancavelica, the largest source in Peru and one known to have been exploited in the prehispanic period (Petersen 2010).

Marine shell

The most remarkable deposit of marine shell found at Chavín is the cache of *Strombus galeatus* trumpets recovered in the Caracoles Gallery by John Rick in 2001 (Rick 2008; van Valkenburgh 2003). *Spondylus princeps* has also been found in ritual deposits (e.g. Burger 1984); like *Strombus galeatus* it is native to warm coastal waters found north of the Bahía de Sechura on the far northern coast of Peru (Gorriti-Manchego 2000) (this southernmost extent is the point used for the cost-path analysis and may be seen on Fig. 2). These two species have a long history of ritual significance in the Central Andes and both appear in ritual contexts in Chavín lithic art (Paulsen 1974). Other species, endemic to the more easily accessible cold waters of the Peruvian coast, are also found at Chavín, including most abundantly *Choromytilus chorus*, but also at least thirteen other species (Sayre and Lopez Aldave 2009: table 1), but as their origins are harder to localize they are not specifically addressed here.

Ceramics

Stylistic analyses and ceramic sourcing (e.g. Druc 2004; Lumbreras 1993; Lumbreras et al. 2003) have convincingly demonstrated ceramics found at Chavín to be non-local, but without pinpointing their places of origin. Lumbreras has argued for North Coast (Cupisnique style, local to the Chicama and Jequetepeque valleys) and Northern Highland (Cajamarca) origins for many of the ceramics that he excavated; the focus of the present analysis is on links to those areas.

I consider the significance of these exotic goods at Chavín in two ways: first, as evidence of the transport of those materials from their origin points to Chavín (while recognizing the likelihood that a variety of motivations may have driven such transport and the possibility that transport may have been indirect), and, second, as evidence from which some portion of the network of interacting sites in which Chavín participated may be reconstructed. Certainly such an effort is not novel (see, for example, Burger 1988: figs 4.1, 4.12; Lumbreras 1974: fig. 5.4), but rather than consider these sites as constituting the extremes to which a horizon extended, or the boundaries of an interaction sphere, the focus here is

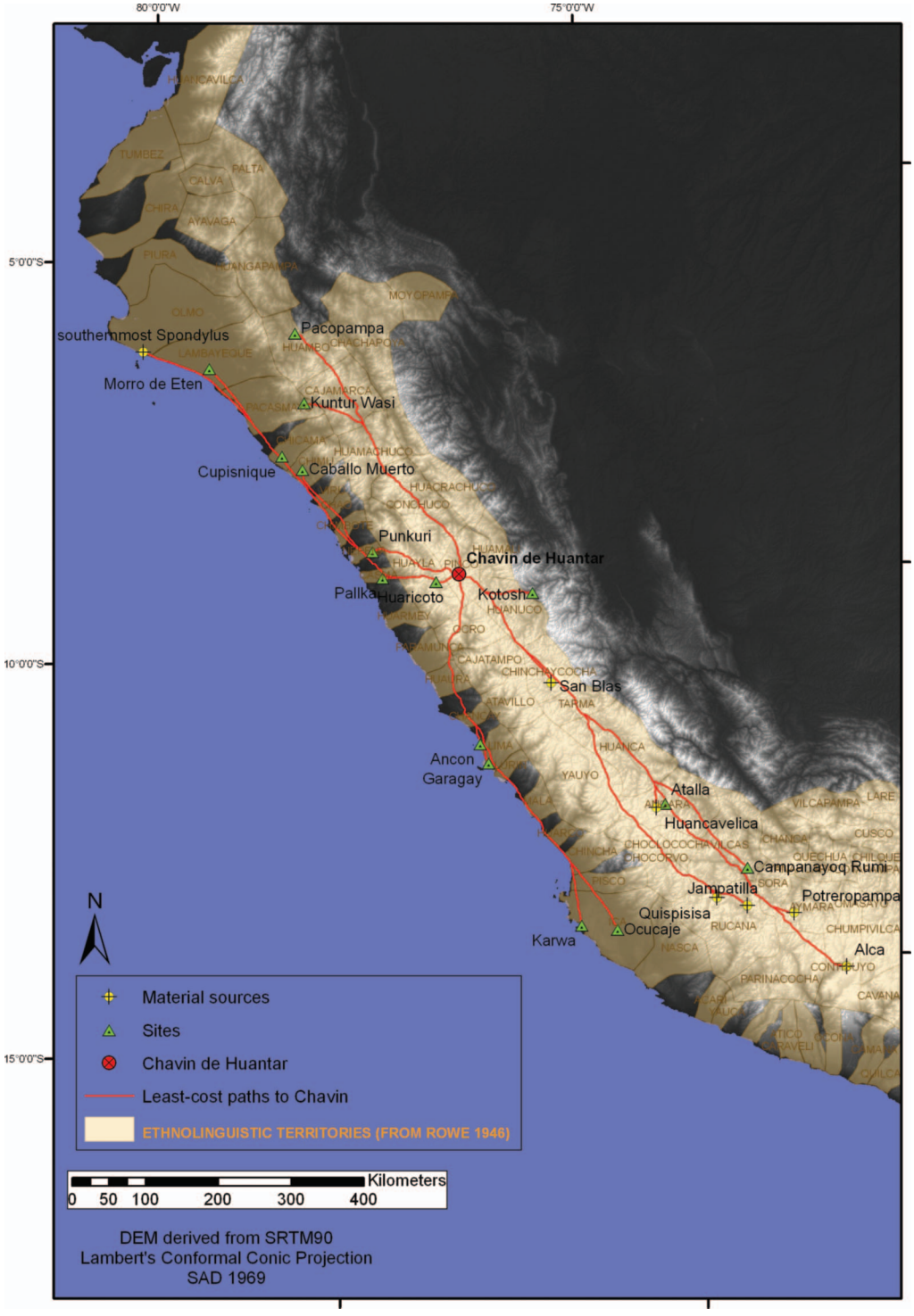

Figure 2 Least-cost paths to Chavín.

Table 2 Routes in the Chavín network

Route	*Exchange type*	*Cost-path length (km)*	*Straight-line distance (km)*	*Number of territories (Rowe 1946) traversed*	*Travel time estimate (hrs, from Tobler's function)*	*Travel time estimate (hrs, at 4 km/hr, derived from cost-path distance)*	*Travel speed (km/hr, from Tobler's function)*	*Travel time estimate (days, at 10 hrs/day, from Tobler's function)*	*Travel time estimate (days, at 4 km/hr and 10 hrs/day, derived from cost-path distances)*
Alca	Obsidian	825	782	13	184	206	4	18.4	20.6
Ancon	Ceramic style	266	241	6	59	66	5	5.9	6.6
Atalla	Ceramic style/cinnabar	457	436	6	49	114	9	4.9	11.4
Caballo Muerto	Iconography	308	264	8	66	77	5	6.6	7.7
Campanayoq Rumi	Iconography/obsidian	612	582	7	134	153	5	13.4	15.3
Cupisnique	Ceramics/iconography	337	298	9	71	84	5	7.1	8.4
Garagay	Iconography	297	270	7	65	74	5	6.5	7.4
Huancavelica	Cinnabar	457	431	6	100	114	5	10	11.4
Huaricoto	Ceramic style	37	34	2	9	9	4	0.9	0.9
Jampatilla	Obsidian	667	622	10	146	167	5	14.6	16.7
Karwa	Iconography	568	527	13	120	142	5	12	14.2
Kotosh	Ceramic style	121	106	2	28	30	4	2.8	3.0
Kuntur Wasi	Architecture/ceramic style/iconography/ idstylestylestyle/ architecture	375	323	5	86	94	4	8.6	9.4
Morro de Eten	Iconography	496	452	11	103	124	5	10.3	12.4
Ocucaje	Ceramic style	593	551	13	125	148	5	12.5	14.8
Pacopampa	Architecture/ ceramic style	453	407	5	103	113	4	10.3	11.3
Pallka	Ceramic style	118	107	3	27	30	4	2.7	3.0
Potreropampa	Obsidian	714	674	11	157	179	5	15.7	17.9
Punkuri	Iconography	143	126	3	34	36	4	3.4	3.6
Quispisisa	Obsidian	621	585	10	135	155	5	13.5	15.5

(*continued*)

Table 2 (*Continued*)

Route	*Exchange type*	*Cost-path length (km)*	*Straight-line distance (km)*	*Number of territories (Rowe 1946) traversed*	*Travel time estimate (hrs, from Tobler's function)*	*Travel time estimate (hrs, at 4 km/hr, derived from cost-path distance)*	*Travel speed (km/hr, from Tobler's function)*	*Travel time estimate (days, at 10 hrs/day, from Tobler's function)*	*Travel time estimate (days, at 4 km/hr and 10 hrs/day, derived from cost-path distances)*
San Blas	Salt	214	201	3	47	54	5	4.7	5.4
Spondylus/ strombus	Marine shell	585	539	12	121	146	5	12.1	14.6
Median		455	419	7	93	114	5	9.3	11.4
Minimum		37	34	2	9	9	4	0.9	0.9
Maximum		825	782	13	184	206	9	18.4	20.6

specifically on their character as nodes in a network. That is, rather than considering the territory between Chavín and these affiliated sites as undifferentiated space, to be shaded on a map as constitutive of an area within which interaction occurred, I focus on reconstructing the routes implied by the logical need to connect these nodes and consider the implications of such routes. Thus, where Figure 1 is notably similar to the map that Lumbreras published more than three decades ago, Figure 2 is more specific in its connections and suggests a more limited type of interaction.

Methodology

In the absence of a Formative Period equivalent of the Inca road system, well-preserved and ethnohistorically documented (see Hyslop 1984), reconstructing exchange routes from the period is necessarily inferential. In thinking about the significance of exotic goods at Chavín, multiple measures of distance are useful – here linear distance (notoriously misleading in the Central Andes), travel distance (approximated by least-cost paths, discussed in detail below), and what is here termed sociopolitical distance (the diversity of ethnic, linguistic, and/or political entities interposed between nodes, approximated by using Rowe's (1946: map 3) map of ethno-linguistic diversity in the Central Andes on the verge of the Inca conquest) are compared.

Cost surfaces and the least-cost paths that can be generated from them are a means of taking into account the variable energetic cost of traversing a topographically diverse landscape. Here I use processed SRTM90 data for the Central Andes – a digital elevation model (DEM) derived from NASA shuttle radar tomography with a resolution of 90 meters, freely available from CGIAR-CSI (see Jarvis et al. 2008) – and Tobler's hiking function used to generate a cost-surface (see Tobler 1993; Tripcevich 2008, 2009) from this DEM using the Spatial Analyst tools in ArcGIS 10. This approach models the energetic cost of traversing terrain of varying slope, calculating accumulated cost across a topographic raster and generating the path that results in the lowest energetic expenditure (see Conolly and Lake 2006: 215–25, 252–6). Comparison with the Inca road network (Fig. 3; see also Matsumoto 2008) suggests that least-cost paths do not match late prehispanic routes very precisely (and indeed least-cost paths generally should not be expected to map exactly onto real-world paths, particularly if derived only from slope rather than from multiple criteria; see Howey 2007; Pingel 2010; Tripcevich 2008). However, I use these in the expectation that they will generate not precise prehispanic routes but rather *plausible* ones, which allow general assessment of the territory to be traversed. Analytical emphasis is on the scale of integration rather than the specific paths generated as the latter are more vulnerable to the model inputs (i.e. choice of DEM and cost-surface algorithm).

In order to consider the implications of communication between these nodes, these routes are used both to generate estimated travel times (recognizing that these may vary for travel on foot and with llama caravans (Tripcevich 2008)) and to consider the diversity of groups that transit of these routes likely involved. Rowe's 1946 map of the tribes and provinces of Peru at the time of the Inca conquest is used as a proxy for Formative Period sociopolitical diversity. Although the map itself is undoubtedly imprecise (based as it necessarily is on scant quantities of spatially explicit information; see Rowe 1946: 185–92),

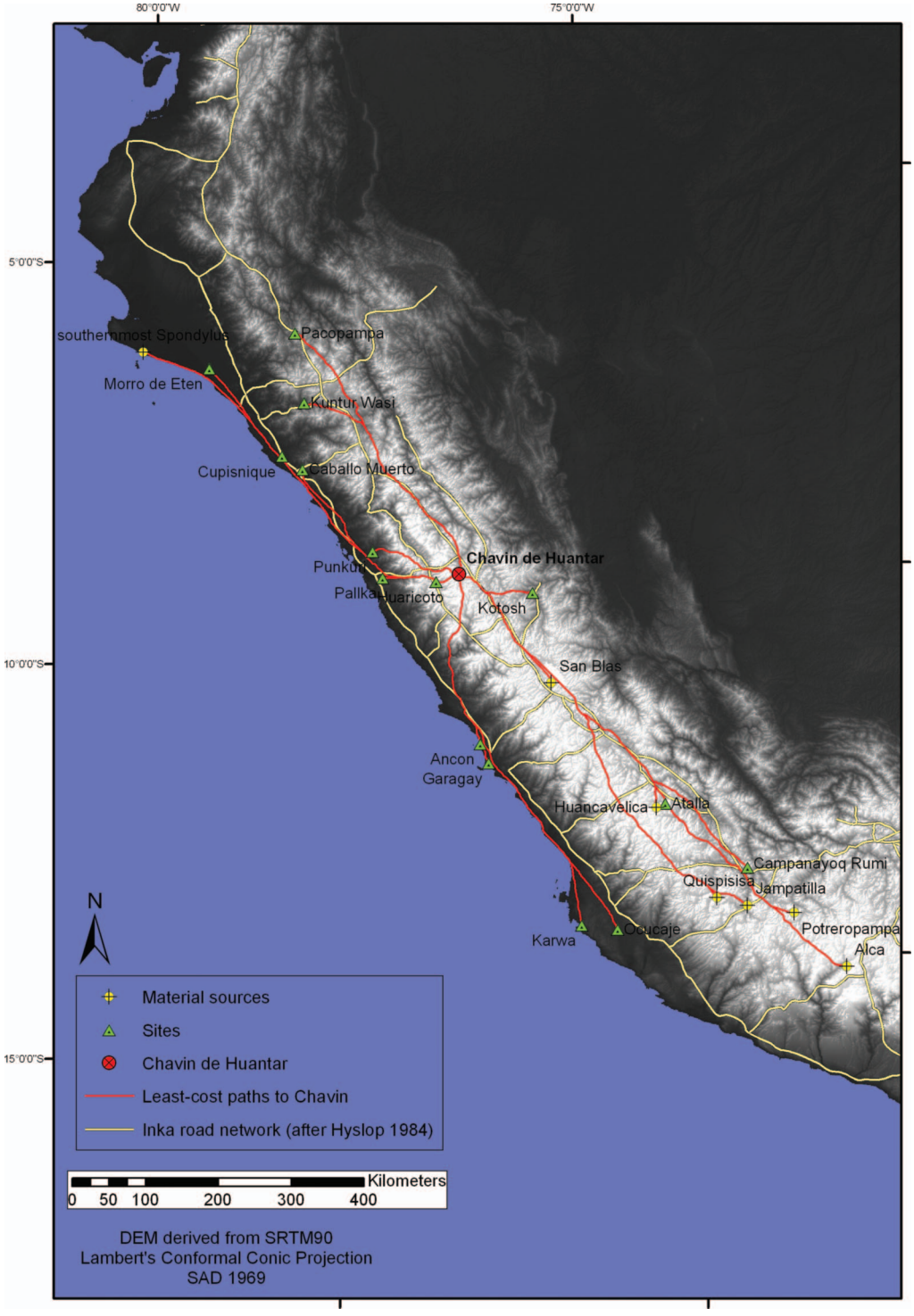

Figure 3 Least-cost paths to Chavín and the Inca road network.

and though the fifteenth century CE should not be mistaken for the first millennium BCE, it is likely that two millennia earlier the Central Andean region housed *at least* as many distinct groups as it did at the time of the Inca conquest. Given the lack of any evidence for the political integration of large areas in the Formative Period, although the specific groups and boundaries on Rowe's map may not be directly applicable they do provide a plausible minimum number of territories for a route to cross.

As Burger (1988, 1993) has emphasized, there was little homogenizing about the Early Horizon, in contrast with the Middle and Late Horizons; given the differentiation of identity dating back to the Late Archaic it is a reasonable working hypothesis that the period likely involved at least as many sociopolitical (and even perhaps ethnic and linguistic) units as were present on the eve of the Inca conquest (see, for example, Hastorf 2008). Rowe's reconstruction of ethnolinguistic territories thus provides both an approximation of the sociopolitical investment necessary to establish such routes and an estimate of the scale of integration implied by the distribution of materials and ideas during the first millennium BCE.

Results

The routes generated using Tobler's hiking function, overlain on the territories that Rowe reconstructed, are displayed in Fig. 2. The various measures of distance – straight-line, least-cost path, number of territories traversed, and estimated travel times – are summarized in Table 2. Using the more conservative estimates for travel times, the sites and material sources with which Chavín was connected vary from one day to nearly three weeks distant, with travel distances ranging up to 825km. Using Rowe's reconstructed territories as a proxy for sociopolitical diversity, those routes traverse as few as two and as many as thirteen territories. Travel of materials and ideas – as suggested by the diffusion of raw materials, iconography, and ceramic and architectural styles – along these routes implies the interaction not just of widely dispersed populations but of a variety of ethnically, linguistically and politically distinct groups.

Combined, these routes suggest the integration of at least forty-one distinct ethnolinguistic territories in Chavín's interaction network. This number would increase if routes between other nodes, rather than simply *to* Chavín, were considered. Moreover, as discussed below, the list of sites included is by no means exhaustive.

The routes themselves, like the Inca road network, and in contrast to transport routes in modern Peru, tend to follow spine of the Central Andes rather than descending to the coast. Modern routes are likely to be responsive to the presence of population and political centers on the coast and to changes in transportation technology (i.e. traffic by rail and road rather than foot and llama). Three of the routes generated are of particular interest for what they suggest about interaction in the Formative Period, and these are discussed in detail below.

Obsidian

All of Peru's obsidian sources are located in the southern highlands and the routes from these sources to Chavín are largely identical for the majority of their lengths. The

Jampatilla and Quispisisa sources lie practically along a single route, suggesting the possibility of accumulating obsidian from both sources in single expeditions, while the same is true of the Alca and Potreropampa sources. Routes from Chavín to the latter two sources pass close to the cinnabar sources at Huancavelica, while both obsidian routes pass close to the salt source at San Blas. Campanayoq Rumi, interpreted as a redistributive center for Quispisisa obsidian at the time of Chavín's floresence, is not on a direct route between Chavín and Quispisisa but rather approximately 65km to the east and close to the route to Alca and Potreropampa. Resources along the spine of the Andes were apparently the focus of north-south transportation routes that necessarily crossed multiple territories.

Marine shell

The least-cost route to the southernmost extent of the natural range of *Strombus* and *Spondylus* species, like the routes from Chavín to the centers of Caballo Muerto and Morro de Eten on Peru's North Coast, takes a relatively direct path across the Cordillera Blanca, the Callejón de Huaylas, and the Cordillera Negra from Chavín before descending the Nepeña Valley and following the coast northward. The consistency in these northern routes suggests that marine shell coming from further north, i.e. along the coast of Ecuador where evidence of intensive prehispanic exploitation of *Spondylus* has been documented (e.g. Martín 2009), would similarly have followed this coastal route. Marine transport is of course also a possibility (and was widespread in later Andean prehistory), in which case material would presumably have been brought ashore further south and transported up the Nepeña or Casma valleys en route to Chavín. The number of territories involved in such trade depends primarily on the degree of marine transport involved, but the presence of other sites affiliated with Chavín's network on the North Coast argues for the existence (though not necessarily exclusive use) of terrestrial routes.

Exotic ceramics

The two major routes of ceramic exchange (see above and Table 1) were to the Cajamarca area and the Chicama and Jequetepeque valleys. In this case the divergent least-cost paths are likely misleading – evidence of interaction between the Cajamarca area and Cupisnique sites on the coast (see Onuki 1995) suggests that a single route linked Chavín to Cajamarca and thence down the Jequetepeque Valley to coastal Cupisnique sites. The putative coastal route descending the Nepeña Valley is less likely to have been the primary vector of Cupisnique-Chavín contact. At the same time, these dual routes emphasize that, like the Inca road network, Formative Period interaction comprised more a web than a series of mutually exclusive routes. The network modeled here should thus be considered a minimal estimate – interaction in the period was *at least* this complex.

Discussion

This reconstructed network provides a basis for informed consideration of the implications of interregional interaction in the Central Andes during the first millennium

BCE, while the factors complicating interpretation suggest focuses for further research. The results: 1) characterize the scale of integration in the period more accurately than the traditional method of isolated points or inclusive areas, and; 2) address the problem of considering the 'space between' as more than an undifferentiated expanse, in both geographic and cultural terms.

Specifically articulating the complications defines foci for investigation and areas where methodological innovation is needed. First, the definition of which sites are to be included in the network is difficult (limited by materials preserved, recovered, and provenienced at Chavín and by the need to define iconographic and/or stylistic affiliations convincingly) and may significantly structure interpretations. Second, the current method does not offer a means of distinguishing between different linkages – i.e. a route along which materials and ideas flowed regularly in two directions is considered on an equal footing with one that saw only occasional and possibly insignificant traffic. Third, all contact is considered to be direct, an assumption made for practical analytical purposes. Fourth, the network as defined here is Chavín-centric, reflecting the scope of the current study rather than any assertion about the nature of interaction during the time period. Finally, there are limitations to least-cost paths, which do not account for a given route's responsiveness to population centers and which are accurate only when energetic (or time) efficiency is the primary travel concern (Kantner 2004).

The issue of defining sites with which Chavín interacted is one that has been addressed repeatedly in Andean archaeology in attempts to define and understand the phenomenon of the Early Horizon. I do not include here all sites linked to Chavín, but rather a small sample that captures the geographic range. Such collections have been most thoroughly attempted in recent years by Burger (1988, 1993) and Bischof (2000); the issue certainly bears revisiting following research of the last two decades, which has both recognized more sites with relevant material culture and significantly revised key chronologies, including that of Chavín (see Rick et al. 2011). Of course, adding links between nodes in addition to highlighting routes to Chavín would present a more realistic picture of Formative Period interregional interaction. The added complexity of such a network is suggested by Fig. 4, which adds links between other nodes, focusing on those most clearly suggested by published evidence.

In such site lists, as in this analysis, an obvious but difficult problem is that both minimal coverage of the eastern slope of the Andes in site surveys and the poor preservation of jungle products (e.g. hardwoods, feathers, plant-derived foods and psychoactive substances, and animal products like pelts, skins, teeth, and claws) at Chavín have served to privilege the coast and the sierra at the expense of the *selva* in considerations of Chavín's interaction network. Although the presence of at least some of these jungle products is suggested by iconographic evidence (e.g. depictions of jungle flora and fauna in Chavín lithic art, particularly the Tello Obelisk (Lathrap 1971)), links to the eastern slopes of the Andes and the jungle are generalized rather than specific to particular sites, rendering modeling of the routes of such interaction impossible, or at least arbitrary.

This study emphasizes the need to focus on considering the quantities and means by which materials were traveling throughout early interaction networks, rather than simply identifying sites as participants in networks. For example, obsidian – the material that had to travel the furthest to arrive at Chavín, by all three measures of distance used here – is

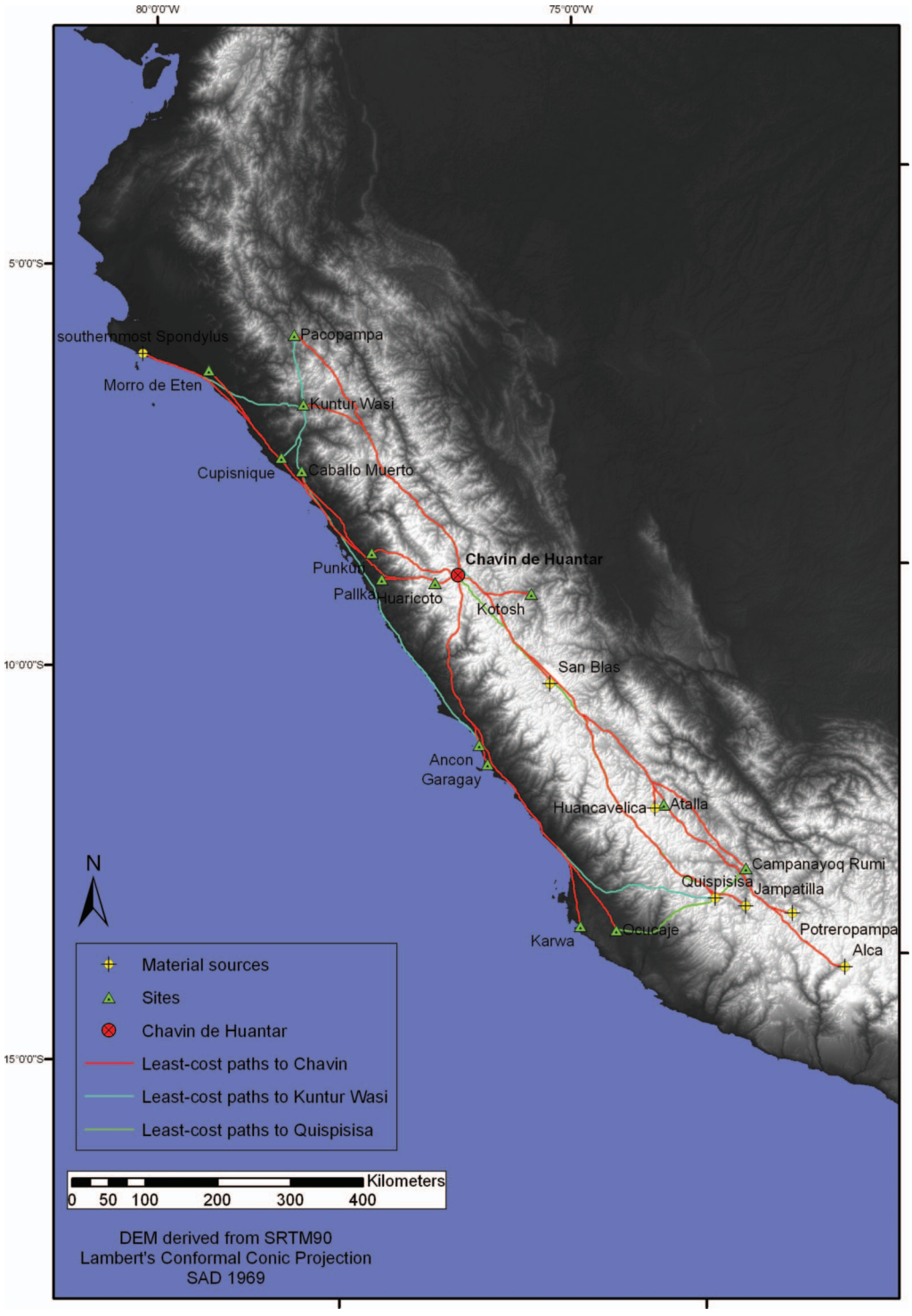

Figure 4 Approaching a more complex network: least-cost paths to Chavín and selected additional routes between other nodes.

the most abundant of the exotic materials at the site and widely distributed there rather than restricted to ritual contexts (Burger 1984; Contreras and Nado in press). This may suggest that multiple motives drove the transport of exotic materials to Chavín and that exotic materials might be treated as prestige goods, economic commodities, or devotional offerings. Distance (measured by various criteria) was apparently not the only criterion of exoticism and associated prestige or ritual potency and, while Chavín may have served as a pilgrimage center, ritual was not the only factor driving interaction. Moreover, modeling sociopolitical distance emphasizes that connecting distant points involves interaction between diverse inhabitants of the space between; using Rowe's map as a proxy for deeper time suggests the scale of sociopolitical interaction implied by such connection.

In methodological terms, the travel times (see Table 2) demonstrate that those generated by Tobler's function are probably somewhat optimistic (see also Tripcevich 2008). I interpret the variability in routes that follow similar corridors (i.e. down the spine of the Andes; for example those to Huancavelica and Quispisisa) as indicating that the routes are underdetermined in local terms – that is, there is an energetic cost minimization achieved by following that general corridor, but within that corridor multiple routes are relatively comparable. Of course, determining energetic cost purely by using slope oversimplifies travel costs considerably. In a steep landscape like that of the Central Andes, slope is often a primary consideration, but nevertheless more sophisticated modeling of travel cost (see Howey 2007) would likely improve the plausibility of routes. The Inca road network provides an excellent point of comparison and diverges notably from the routes generated here (Fig. 3), although this may represent either a reconfiguration of trade networks between the Formative and Inca periods or inaccurate modeling of Formative Period routes. Examining the two sets of routes in areas where they traverse similar corridors (rather than across large areas where they have differing endpoints) suggests that the Inca roads may either match least-cost paths relatively closely or diverge widely, suggesting that they respond to slope, but to other imperatives as well.

In sum, this analysis serves as an example of mobilizing data other than simply site locations to address questions of interaction and connectedness, highlighting the fact that creativity in this vein is critical if we are to understand the scale and character of integration in the first millennium BCE Central Andes. Better sampling and quantification and more robust sourcing of exotic materials at multiple Formative Period sites, as well as intra-site analyses of the consumption of those materials, will enable more in-depth analysis of the interaction networks of the time. In addition, implementation of multi-criteria cost surfaces may aid in further delimiting likely routes. Reconstructing such routes, as I have explored here, has the potential to change our understanding of the burgeoning regional interaction of the period.

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