THE 1993 EXCAVATION SEASON AT GÖLTEPE, TURKEY

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In 1993 the Early Bronze Age workshop and habitation site of Göltepe and its associated tin mine, Kestel, became the newest members of the Oriental Institute excavation roster. Excavations at Göltepe during the 1993 season were directed by K. Aslıhan Yener and were designed to illuminate the origins, formation, and organization of tin production in the central Taurus Mountains of Turkey. Discovered during ten years of archaeological and mineralogical surveying in metal-rich zones, the results of these archaeometallurgical investigations yielded the solution to an enigma puzzling scholars for decades—a source of the elusive tin of antiquity, a 5–10% concentration of tin with copper that produces a good bronze.

The 1993 excavations were conducted under the auspices of the Turkish Ministry of Culture, Directorate General of Monuments and Museums. The team consisted of field director Thomas Chadderdon and field supervisors Chris Monroe, Eric Klucas, Eric Jean, and Philip Andrews. The groundstone tools were tackled by Dr. Robert Hard and the ceramics by Dr. Sylvestre Duprés and Behin Aksoy. Conservation was ably managed by Stephen Koob and Fazıl Açıkgöz. Replication smelting experiments and analyses of metallurgical debris were undertaken by Bryan Earl and Dr. Hadi Özbal. Palaeobotanical materials were studied by Mark Nesbitt and the faunal collection by Dr. Alan Gilbert. Analyses of crucible slag and residues were undertaken at the University of Chicago by Dr. Ian Steele, Mieke Adriens, and Laura D'Alessandro of the Oriental Institute. Ayşe Özkan and Brenda Craddock comprised the illustration staff. Tony Wilkinson of the Oriental Institute researched land use patterns. John and Peggy Sanders of the Oriental Institute Computer Laboratory digitally rendered the topographical maps and plans.

Göltepe is located two kilometers opposite Kestel mine on top of a large natural hill in south-central Turkey. The hill measures close to sixty hectares total and is fortified at the summit, with cultural deposition throughout the entire extent of its surface. The size of the settlement is estimated to be between eight to ten hectares, and combined with the Kestel slope occupation probably totals sixty hectares in a man-mine system. ^{14}C uncalibrated dates from the 1990 season at Göltepe range from 3290–1840 B.C. A dendrochronological date of 1978 ± 37 years was obtained for a piece of charcoal from a pit fill context. Five samples of charcoal from excavated contexts inside Kestel mine gave radiocarbon determinations 2070–1880 B.C. calibrated to 2870–2200 B.C., dating the use of Kestel mine firmly in the Early Bronze Age. Another series of six recently obtained dates suggests an earlier beginning for the mine, 2740 B.C. ± 100 calibrated to 3240–3100 B.C. Excavations began at Göltepe in 1990 and continued in 1991 and 1993. Parallel excavations proceeded at Kestel mine in 1987, 1988, 1990, and 1992.

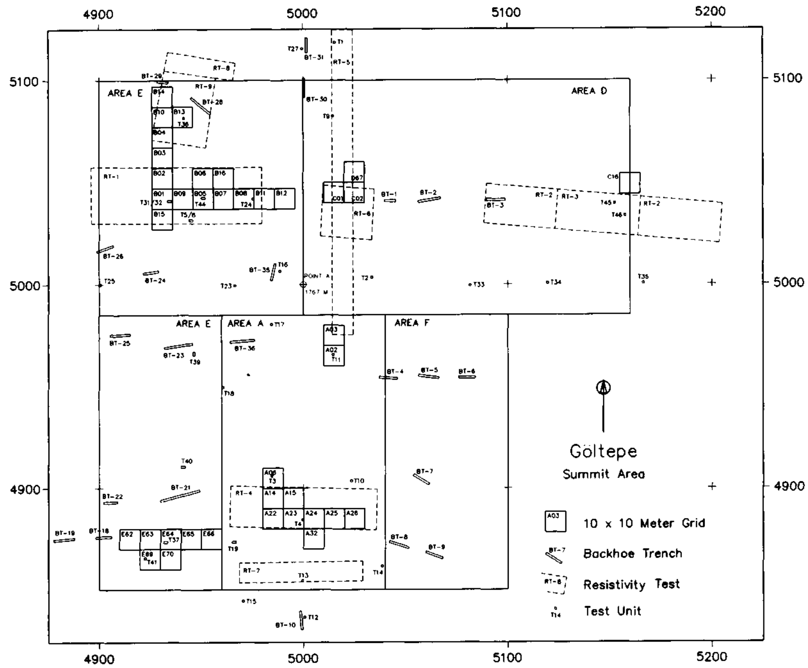

Figure 1. Excavation units, Göltepe 1993

A total of 858 square meters were excavated at Göltepe in 1993 (fig. 1). Göltepe is architecturally unlike any site in Turkey—the workshop/habitation units are ovoid semi-subterranean and fully subterranean pit structures, which are cut into the graywacke bedrock with smaller subsidiary bell-shaped pits in association with it. Smaller houses measure 4–6 meters in diameter. Larger units measure nine by seven meters and are terraced off the slope, much like the neighboring mountain village, Celaller. The superstructures of these units are wattle and daub and great numbers of branch impressions on mud and structural daub substantiate this suggestion. Postholes were found in a number of structures this year, which may enable us to reconstruct the shape or pitch of the roof. Unique also are what appear to be clay structural elements—geometrically designed panels, which may have decorated the interior spaces of the pit structures or provided decorative borders for doors, bins, and altars.

Due to the difficult nature of the cultural deposition, that is, pit houses dug from above with very little overlay, extremely delicate and meticulous care was afforded the excavation trenches in the four areas of excavation: Trenches B05/B06, Trenches E62–E67/E69/E70, Trenches C16/C01/C02/D67, and Trenches A15/A23/A24.

Area A (Trenches A15/A23/A24)

The excavations at the southern end of the summit expanded trenches that were begun in previous seasons. A total of sixty-two square meters were exposed in this sector. Two pit structures measuring 2.0 × 2.8 meters and 3.5 × 2.0 meters (fig. 2) were exposed that appear to be workshops as inferred from the contents of the rooms. Postholes were identified in the larger pit structure, A23-0900-015, and a superstructure of wattle and daub is inferred by the branch impressions on vitrified mud lumps in collapse levels. These units were plastered repeatedly and decorative panels of clay were found inside, which may have been used on the walls. An additional seventeen smaller pits were cut into the bedrock, probably serving refuse and/or storage functions, and ranged in size from under one meter in diameter and less than one-half meter in depth to several meters. All of the pits were filled with debris of a similar nature—small to medium stones, groundstone tools, relief decorated slabs, tin-rich crucible fragments, powdered ore and ore fragments, charcoal, and ceramic sherds.

Of special note were two floor assemblages—an entire metallurgical tool kit (fig. 3), consisting of a moveable brazier, crucible with stone cover, groundstone ore crushers, mortars, bucking stones, kilograms of ore powder, and ore nodules.

Five phases (see below) could be identified in this sector. A major stratigraphic and architectural break is visible between Phases III and II, when the pit structures were intentionally filled in and free standing—above ground—stone structures were erected over them.

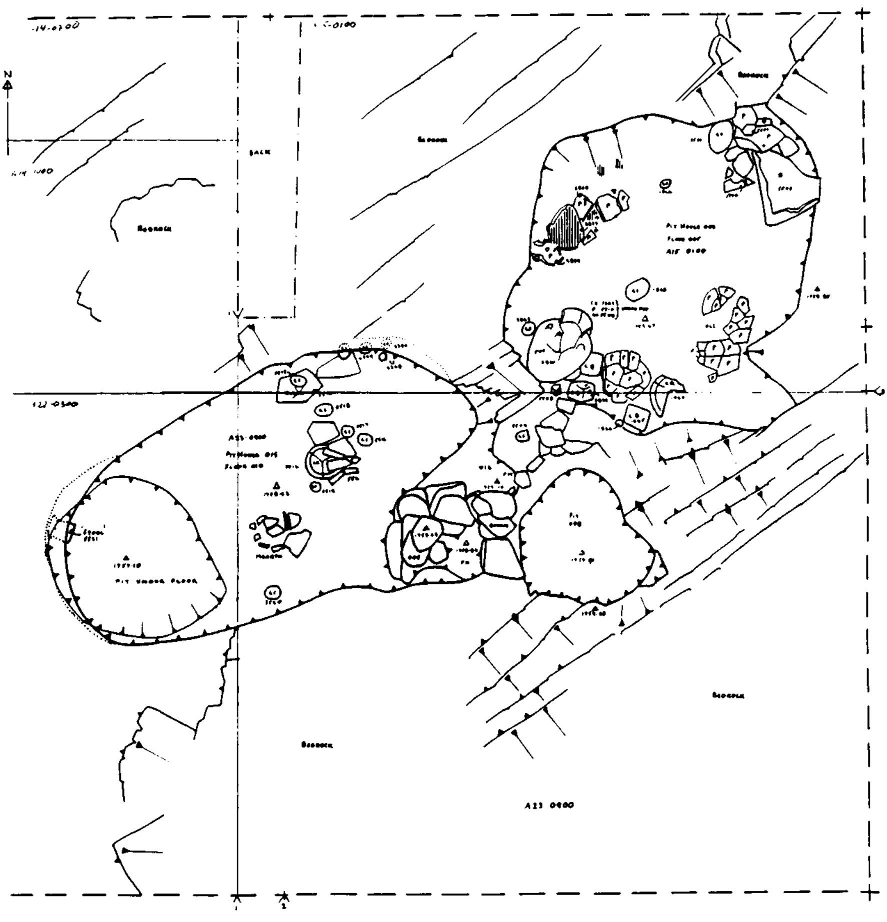

Figure 2. Early Bronze Age pit house structures A23-0900-015 and A15-0100-006 with metallurgical floor assemblage, Göltepe 1993

Area B (Trenches B05/B06)

Area B presented evidence of somewhat different architecture and greater depth of deposit. A total of one hundred fifty-four square meters was exposed in this slope facing the mine. A one meter wide profile trench and resistivity testing in 1991 had already revealed a strikingly dissimilar cultural topography from the current natural topography. The profile indicated that three terraces had been cut on the slope into the bedrock for leveling and structures were constructed into each of the terraces. One terrace was trenched up to four meters and walls were erected in front and parallel to these cuts in a substantial slope structure. This mode of construction is still in evidence in Celaller village, which gives the appearance of extensive slope trenching to emplace houses similar to a staircase, each roof serving as the front entrance of the house above.

The decision was made to expose the larger structures and one unit measuring 9 × 7 meters was bordered by a stone wall on the eastern side but was cut into the bedrock on the northern and southern sides. No wall was found on the western, downslope side, thus the method of roofing and the exact size of the unit is still unknown. A plastered feature with three compartments, which was built with small stones and reused clay blocks with geometric designs, was found in the northern side of the room. To the south of this bin-like feature a floor assemblage was located consisting of 10–12 kilograms of powdered ore, groundstone tools, and ceramics. Another house unit, cut from above and partially destroying the southern edge of the first structure, may be slightly later but is still dated to Phase II. A geometrically decorated altar-like clay feature (fig. 4) slightly off center in the room and a pyrotechnological feature in the northeastern corner were found in situ. Finds found on the floor and fill of this structure included groundstone mortars, grinders with ore still on the stones, kilograms of powdered ore, crucible fragments, a lead ingot weighing 170 grams, and a silver-tin alloy necklace.

Areas C and D (Trenches C16/C01/C02/D67)

The excavation of this area was motivated by the results of resistivity testing. A total of 165 square meters were excavated. Several large subsurface features had emerged in 1991, and a decision was made to locate these units in an area that was largely unexcavated in previous years. After a number of fruitless shallow exposures, Early Bronze Age pit structures with ovoid plans emerged paralleling the earlier finds on the other sectors of the site. Several internal modifications had been made in these units; for example, rooms or storage compartments were added by erecting scrappy stone walls. Large storage vessels, clay figurines, molds for metal implements (fig. 5), powdered ore, and crucible fragments emerged from the floor and fill inside these units.

Figure 3. Crucible with stone cover, gabbro grinding stones, powdered ore and slag, metallurgical floor assemblage, Göltepe 1993

The structures were burnt in a final phase of collapse and abandonment.

Several Iron Age levels, which belong to Phase I, were discovered in this sector and on the summit. The first evidence of Iron Age settlement of the site had been revealed in the 1991 Area B exposures and in 1993 we identified several re-used Early Bronze Age pit structures that dated to the early Iron Age. A floor was discovered with iron implements and ceramics in situ and a well-preserved hearth was found in the western corner of an Area D structure. A limited, perhaps seasonal occupation can be inferred from these scrappy remains.

Figure 4. Early Bronze Age relief decorated clay feature, Göltepe 1993

Area E (Trenches E62–E67/E69/E70)

The widest horizontal exposure, 165 square meters, was achieved in this area situated on the southwestern slope (see *Computer Laboratory* report (below), fig. 4). In 1990 a number of test pits revealed the depth of deposit and possibility of subsurface structures. In addition an attempt was made to expose the southern extent of the circuit wall, exposed in Area B further to the north at the same elevation. The circuit wall was indeed revealed and found to be constructed of large and small irregular blocks of limestone. A minor entrance into the settlement and a street leading in a northeastern to southwestern direction were identified. Several terrace walls were trenched into the bedrock further upslope in this sector as well.

One pit structure with several phases of occupation was identified with a large collection of pottery on the floor. Several large storage vessels were found placed in the eastern side of the room. To the south of the pit house, a midden containing thousands of crucible fragments of the larger variety (20–50 centimeters), as well as a great amount of powdered ore (30 kilograms) was unearthed. Many refuse pits yielded typical debris of metallurgical nature.

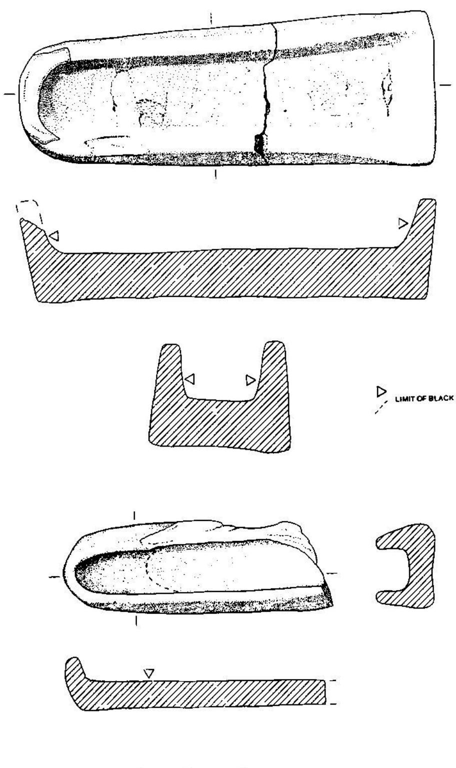

Figure 5. Early Bronze Age clay utensil molds, Göltepe 1993

In a bell-shaped pit underlying the midden, crucibles with smaller diameters were found, suggesting that the size of crucibles may have increased in time. Another refuse pit contained hundreds of cow and sheep/goat horn cores.

Overlying these pit structures and bell-shaped pits were remains of Phase II, with large, above ground stone structures. Seemingly filled and leveled in one event, the pit structures were superseded by a house terrace measuring nine by fifteen meters. No plans or remains were found of the structure that assuredly would have been erected on top of the terrace. Several stone walls placed in an east-west orientation, as well as the circuit wall, date to this period of expansion at the site.

Stratigraphy and Phasing

Basal pits distinguish the earliest phase, Phase V. Phases III and IV are characterized by subterranean pit structures and bell-shaped storage/refuse pits. Tentatively they correspond to the Early Bronze Age II period on the basis of pottery parallels with Tarsus. The bulk of the ceramics are burnished wares and Anatolian metallic wares.

A stratigraphic break and architectural reorientation is represented by Phase II, which is characterized by the construction of above surface free standing structures and represents a period of expansion. The walls of Phase II buildings were often built over the underlying pit houses that were filled in with industrial and domestic debris. Although pit structures continued to be built, large walled structures are erected on top of massive terraces constructed of colluvial stones. In Area E, only the terrace is preserved; the architectural plans of the structure are lost to erosion. The circuit wall dates to Phase II and corresponds roughly to Early Bronze Age III in Tarsus terms. At Tarsus there is an architectural break between Early Bronze Age II and III as well, when megaron-related structures appear.

The uppermost levels are assigned to Phase I, which includes topsoil and transitional levels that span from the collapse and abandonment of the site at the end of the third millennium B.C. to the mixed context of the Iron Age. In one restricted sector of the eastern slope, Iron Age reuse of Early Bronze Age pit houses was identified.

Site Size Determination

Determining the horizontal extent of the site was an important goal for the 1993 season since a size of sixty hectares is an anomaly in such an agriculturally unfavorable environment. In previous years subsurface features were mapped by magnetic resistivity sampling in tandem with one square meter test pits in an attempt to determine the size of the site. During the 1993 season, thirty-six stratigraphic profile trenches were executed over the entire site. These stratigraphic trenches were one meter wide and ten to twenty meters long; profiles were drawn for both sides of the trenches. A total of 338 square meters of stratigraphic trenches were executed in a radial configuration around the site.

This procedure allows two conclusions to be drawn. First, the circuit wall does surround the site, although in places it may also function as a terrace wall. Secondly, the perimeter of the site is now more in line with a believable area. The area of greatest density, within the walls of the summit, measures five hectares; less dense, scattered extramural settlement covers eight to ten hectares. This is a conservative estimate and it is still possible that pit houses were dug all over the landscape between the site and the mine. These estimates, of course, do not include Kestel mine, or its one kilometer slope area, where evidence of structures and contemporary pottery was also found in previous seasons of work. Thus, linked together as a man-mine system, the sixty hectares total is probably close to reality.

Establishing Tin Metal Production Yields

Some of the more important finds related to the processing of tin have been the vitrified earthenware crucibles with a glassy slag accretion rich in tin. Constructed with a coarse straw and grit tempered ware, the crucibles have slagged surfaces with a tin content of 30 to 90% and rim diameters that range in size from six to fifty centimeters. In some instances tin metal particles were entrapped in slag and identified by microprobe, scanning electron microscopy, and x-ray diffraction as the product of the smelt. The activities, which are demonstrated by analysis at the Conservation Analytical Laboratory of the Smithsonian Institution and the Enrico Fermi Institute of the University of Chicago, include a labor intensive, multi-step, low-temperature process carried out between 800° and 950° C.

Processing involved intentionally producing tin metal by reduction firing of tin oxide in crucibles—with repeated grinding, washing, panning, and resmelting. The raw materials being processed in the crucibles consisted of tin oxide (cassiterite) with no copper ores present, along with calcium carbonate, iron oxide with minor amounts of magnesia and titania, an alumino-silicate containing more than 12% potassia, and soda and charcoal as the reduction agent. This recent evidence finally puts to rest the initial skepticism as to the concentrations of tin in the Taurus and reveals it to be an important tin processing center.

Measurements were made of industrial debris in an effort to define quantitatively processing parameters. Some seventy kilograms of ore powder and fifty kilograms of ore nodules from excavated contexts were weighed and the total assemblage of crucible fragments from this season alone weighs one ton. In addition, chronological distinctions can now be made with the varieties of crucibles found in different sectors of the site, which will enable a clearer picture of how the industry changed through time to meet increasing demands for the product, tin. An earlier, smaller crucible type (17–20 cm diameter) and a later, larger crucible (20–60 cm diameter) will be part of the database for a household assemblage investigation of craft production. A substantial amount of ground ore was found inside ceramic vessels. Some ore powder may represent slag, which may have been pulverized to release the tin ore entrapped in the slag during the smelting process. Flat ax and chisel molds made of clay were also found. Since no debris, slag, or material relating to copper production was found at the site, it is assumed that the alloying process took place elsewhere.

In conjunction with the above analytical programs, several replication experiments are now on-going to test the feasibility of the production model, the physical conditions required, and the expected end products. B. Earl of Cornwall and H. Özbal successfully smelted tin metal in the field in 1992 and again in the laboratory during 1993–94 utilizing tin powder found in Early Bronze Age II/III contexts. Enriching with one cup of water a low grade 1% cassiterite ore mixture to approximately 10% by vanning (panning with a shovel), this charge was then placed in a homemade crucible made with local clay and chaff temper. The charge, which was found in cups from the floor of Early Bronze Age pit structures, was placed in successive layers of charcoal and after twenty minutes of blowing through a blowpipe, tin prills entrapped inside an envelope of glassy slag emerged inside the crucible. During this experiment tin metal prills (globules) encased in glass slag were released by grinding with a lithic tool. The slag was thus in powder consistency and was virtually invisible unless microscale sampling methods were introduced.

While it is recognized that cassiterite alone will smelt directly in a crucible, such a process requires reduction by carbon-rich gases and would generate little slag. Smelting thus results in a multi-step production of tin metal with refining accomplished by washing, grinding, and remelting. Although highly labor intensive, the smelting process is simple and does not require technical sophistication. The industry as a whole, however, does represent a sophistication typical of third millennium metallurgy in Anatolia. The skill of the ancient metallurgists was highlighted by a new find, a coiled necklace made of an unusual alloy: silver, tin, zinc, and copper. Other metal objects, such as bronze and lead, as well as molds were excavated from the pit houses.

Computer Digitization of Topography and Site Plans

Upon becoming a faculty member at the Oriental Institute several research facilities became available for the project. One of the most important is the Computer Laboratory run by John and Peggy Sanders. The architectural plans of Göltepe and the large and small scale site plans with contours and excavated areas were all digitized using AutoCAD version 11 on an IBM-compatible computer. At this point the plans of the excavation are being plotted in AutoCAD as well, whereas the large-scale surface terrain of the entire mountainous region around the site is being produced with the ARRIS program and its Topographer module on a Sun SPARCstation computer.

Assessment of Results and Prospectus for Future Work

An expanded program is planned in subsequent seasons. Apart from the testing of excavation units, processing, analysis, and recording procedures and systems, the areas of excavations were successful in providing information on a number of points important for determining future operations.

First, it is apparent that most of the hilltop site was occupied during the same period—the early/mid- and mid-/late third millennium B.C.—with some clues of possible earlier or later occupation. The area enclosed by the circuit wall (300 × 450 m) may suggest that all sectors were part of a single settlement rather than complementary and alternating smaller settlements. However, the 1993 excavations have demonstrated that in the late third millennium the settlement expanded beyond the circuit wall. The prospects are excellent for aiming at deriving data for zonal urban quarters and other aspects of intra-site organization, especially since coherent architectural remains are to be found in well-preserved levels just below the surface. Zonal patterns are indeed indicated not only by the morphology of the site, but also by differences in architectural units in A23, A24, (domestic and specialized), B05 (public), B06, E69 (specialized), and other features of as yet indeterminate character (stratigraphic trenches on the lower slopes). This variation is further supported by finds contexts: concentrations of crucible fragments, molds, dressing stones, and ores in Areas A and B; the large scale mortars and workshop stalls in A15 and A23; and the pithos storage jars and domestic utensils in E63 and D67.

Since the western slope does indeed yield the remains of a more substantial public building complex surrounded by domestic and/or industrial quarters on the spurs and terraces, it is interesting to ponder the apparently distinct role played by the workshops along the slopes of the Kestel mine and the linkage between them and the workshops on Göltepe. It seems logical that the Kestel slope area must have been used for a special purpose. Alternate explanations for the use of this area may be as a separate year-round settlement at Göltepe with industrial sectors for fine dressing and casting of metal, as a separate ceremonial sector located at the larger site, as a seasonal settlement with heavy crushing workshops at Kestel, or as a commercial sector or trading harbor at the larger site at the lower slopes near the silk route crossings.

Since few of the finds have been analyzed in any detail, a couple of points relevant for future study can be raised. First, the occurrences of crucible fragments with tin-rich slag accretion, ingot molds, and vast quantities of ore and ore dressing stones point to an important early urban industrial activity. The appearance of tin bronzes at this time and their distributions in Anatolia, Syria, and Mesopotamia have long been documented, but their production and transmission—which follow a distinct qualitative and quantitative pattern during the period of early urban formation and increasing Mesopotamian demands—have not been examined in detail commensurate with their potential importance in tracing commercial patterns in this area. In theory metallurgy is a constantly changing technology. A number of attributes that also vary with these changes can be easily measured in the field. For example, it would be possible to see shifts from production level of a cottage industry to more complex strategies. The intensity of metal production and the organization of metal crafts are archaeologically definable at Göltepe. Extraction of different ores, changes in smelting installations, changes in metallurgical residues such as crucible slag, or a shift in semifinished products such as ingots may have been for political or socioeconomic reasons unrelated to metallurgical knowledge. If there is an initial development, and a later stagnation linked to economic fluctuations in the demand of metal as a commodity, other aspects of material culture would co-vary with the increased demand for metals. Second, an analysis of individual building units, or larger community patterns, has rarely been possible or attempted for the highland metal zones. Changes in the organization of domestic areas, storage facilities, workshops, and in the quantities and variety of goods within these areas would need to be investigated. Göltepe has provided an ideal opportunity for defining the archaeological cognates of craft specialization and its organization. Finally, an analysis of ecofactual material, the semi-subterranean architectural techniques, as well as lithic remains, suggesting hunting-gathering continuity and the impact of this whole industry on the environment and vice versa has rarely been possible or attempted for such an alpine resource zone.

Conclusion

The work done during the 1993 season has gone a long way towards couching intelligent questions regarding the context and organization of tin production in the region. Were specialist laborers operating out of a larger site? Was it part of a more complex system or was it a cottage industry? The possibilities are interesting and quite varied. Clearly tin was processed at Göltepe, and to judge from the quantities, on a large scale. This ground breaking investigation will continue to generate data that will enable us to define an unknown technology of critical strategic importance. The research has clearly defined goals for understanding the technology within its cultural context. The proposed research will investigate tin production in terms of technology, the archaeological context, and its integration with neighboring regions. The chronological and cultural sequences for Göltepe and Kestel will provide an important frame of reference for a critical region of the ancient Near East that is little known archaeologically.