Spying on the Ancient World: *Archaeological Applications of Declassified US Intelligence Satellite Photography in the Near East*

Jason Ur
Department of Anthropology
Harvard University

Introduction: Space-Based Archaeology

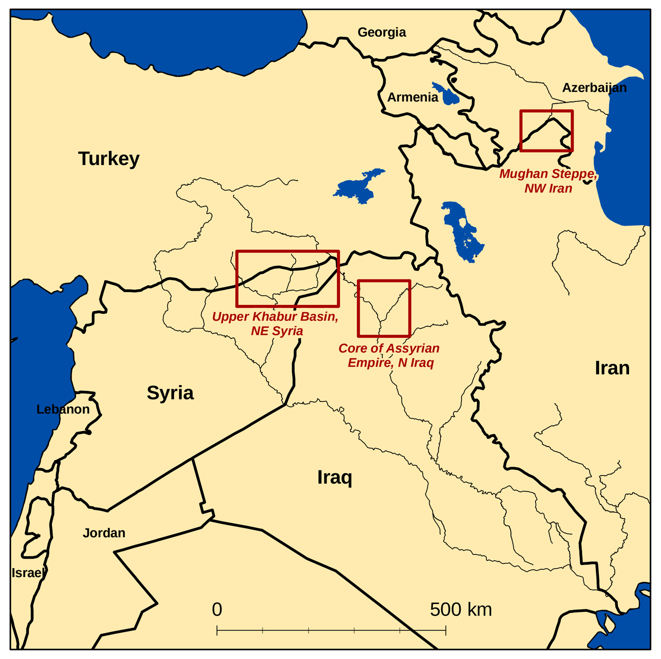

Fig. 1. The Middle East, with case study regions indicated.

The primary goals of archaeological research are to document variations in the material remains of past societies, to reconstruct their social, political, and economic structures, and to understand how and why they evolved through time. Excavation, the most recognized archaeological data collection method, is an intensive process which recovers a large but spatially restricted amount of data, and is therefore suitable for investigating small scale social phenomena. Some important aspects of ancient society, however, are understandable only on a regional scale; for example, the evolution of settlement patterns, human-environmental interactions, and land use. For research addressing these issues, a correspondingly more spatially extensive method is necessary.

Archaeologically informative patterns at the regional scale are extremely difficult to perceive from a ground based perspective. Thus, archaeologists have relied on a combination of fieldwalking and remote sensing, to reconstruct ancient landscapes. In many parts of the world, newly independent nationalist states have not made aerial photographs available to foreign researchers. This situation has been especially true of many modern Middle Eastern states. For such "denied" regions, the availability of newly declassified American intelligence imagery has been productive (Fowler 2004). This poster uses four case studies from three regions of the Middle East to illustrate how these images can be used to reconstruct past settlement and land use (Fig. 1).

The CORONA Mission and its Declassification

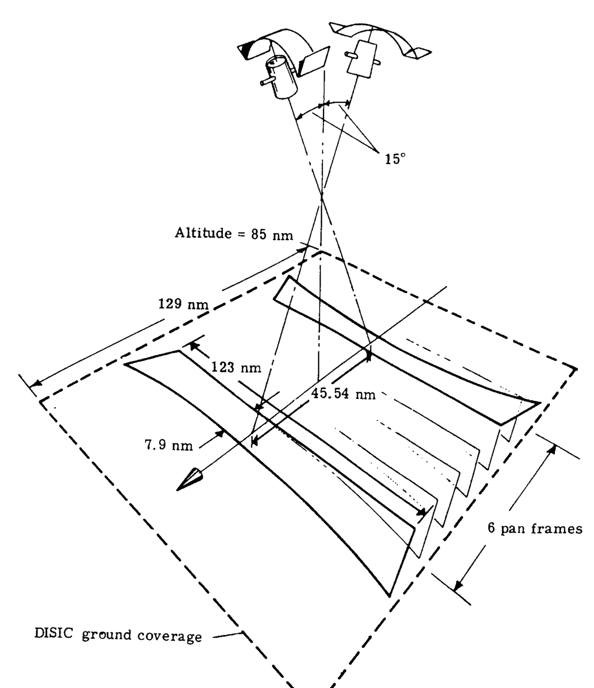

Fig. 2. The camera system on board the CORONA satellite and the ground footprint.

CORONA was the United States' first intelligence satellite program, which was originally designed to give American military planners an estimate of Soviet nuclear missile capabilities (Fig. 2). In thirteen years of operation (1959-1972), it produced over 800,000 images which covered 557 million square miles, the equivalent of the entire land surface of the earth almost ten times over (Fig. 3; Day, Logsdon, and Latell 1998, McDonald 1997). During its existence, the program used an evolving set of cameras. The earliest (KH-1) produced photographs with a ground resolution of 40 ft. The last two cameras, used on KH-4A and KH-4B programs, had a highest resolution of 9 ft and 6 ft, respectively. Because the CORONA satellites carried film cameras, rather than digital sensors as is the current standard, the film had to be physically returned to earth via parachute, where it was collected out of the air by military planes. The photographs from the CORONA program were declassified by executive order on 22 February 1995 and can now be previewed and ordered via the United States Geological Survey (USGS) website at http://earthexplorer.usgs.gov.

Fig. 3. Regions imaged by a typical mission (Mission 1017, launched 2 November 1964).

Applications in Near Eastern Archaeology

Fig. 4. Tell Zanbil, a mounded archaeological site in northeastern Syria

CORONA imagery can be used to great effect in identifying sites, mapping offsite archaeological features, and reconstructing ancient environments. Mounded sites (Fig. 4) are easily identified by the shadows they cast. However, even sites with little or no topographic expression can be recognized. In alluvial areas of the Near East, ancient sites appear as lighter spots (Fig. 5). This signature is a product of the anthropogenic nature of their soils, which have a different color and lack the developed soil structure of the surrounding fields. These unstructured archaeological deposits shed moisture more effectively.

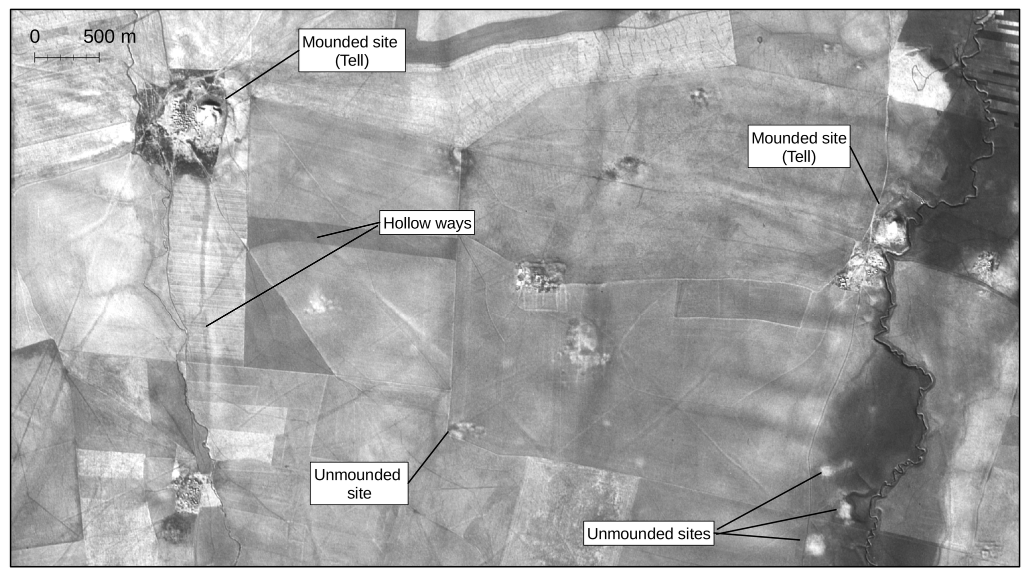

Fig. 5. Mounded and low- or unmounded sites on CORONA photographs from northeastern Syria. Mission 1102, Dec 11 1967.

Sites and Routes of Communication in Northern Mesopotamia

Fig. 6. Ground view of a depressed former trackway ("hollow way")

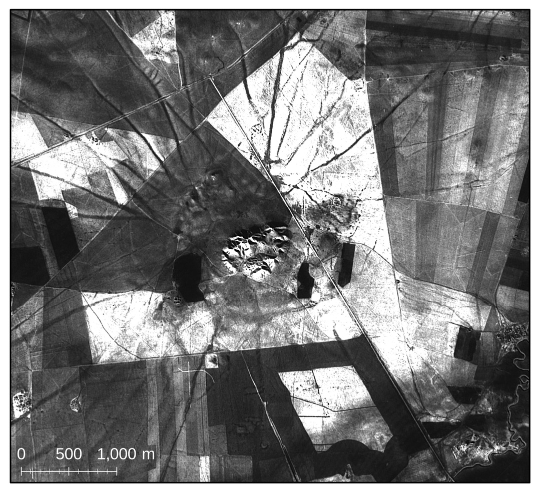

Fig. 8. CORONA image of Tell Brak, with radial pattern of trackways. Mission 1102, Dec 11 1967.

In the later Early Bronze Age (ca. 2600-2000 BC), a series of cities of ca. 10,000-20,000 persons emerged in Northern Mesopotamia, modern NE Syria, SE Turkey, and N Iraq. Excavations have revealed that they contained elaborate palaces and temples, and their rulers administered them with the aid of cuneiform writing (Stein 2004). These cities existed amid robust rural hinterlands of smaller towns and villages (Wilkinson 1994).

To maintain such high urban populations, their residents intensified their agricultural production, and brought in surpluses from nearby villages. The routes of communication have survived in the form of hollow ways. These features appear as broad linear depressions in the landscape, formed by the passage of human and animal feet (Fig. 6; Wilkinson 1993, Ur in press). Moisture collects in these features and encourages plant growth, which appears darker in CORONA imagery (see Fig. 5). Thus the signature of a typical hollow way would is a dark line which disregards the modern field and track patterns (Ur 2003).

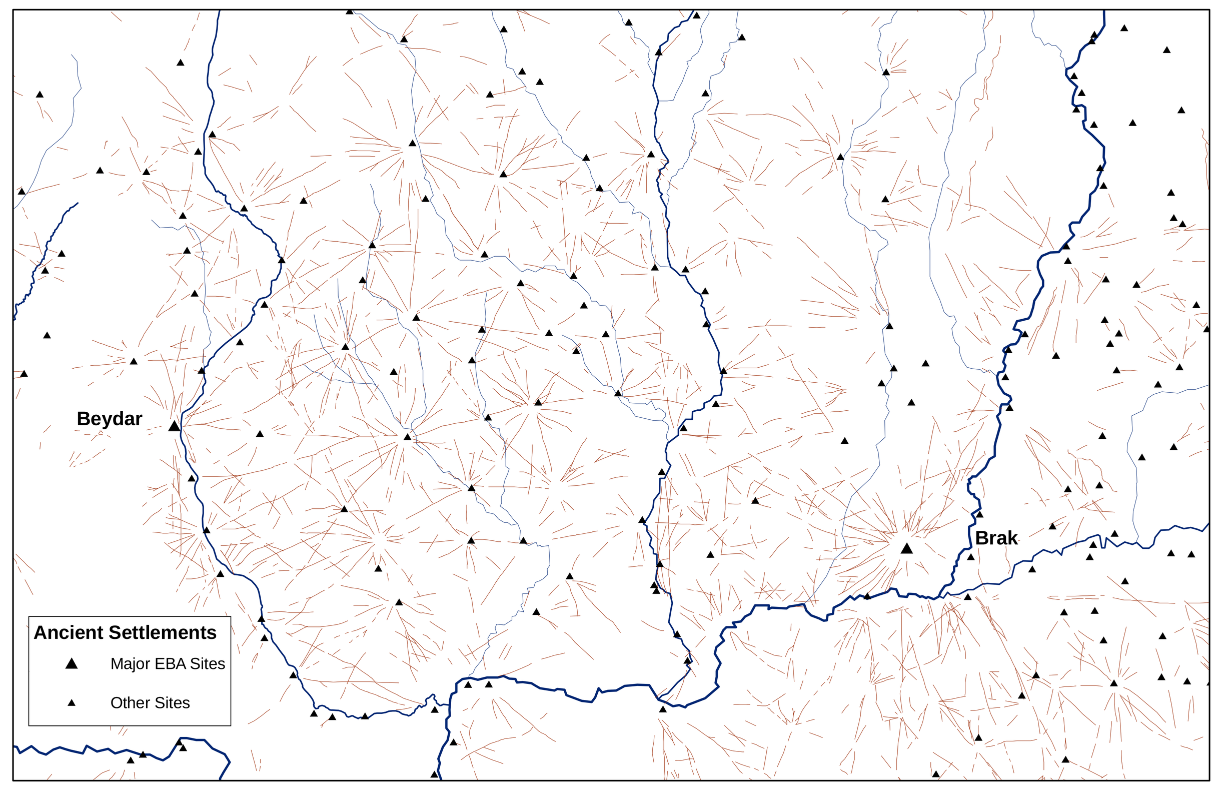

Fig. 7. Regional network of ancient tracks in NE Syria, mapped from CORONA photographs

Hollow ways are difficult to perceive from the ground but are easily identified in CORONA photographs. At a regional level, settlements were connected in a lattice of routes (Fig. 7). Most hollow ways, however, simply faded out 3-5 km from sites (Fig. 8). These routes led not to other settlements but were used by farmers, shepherds, and their flocks to move from the settlements out into the fields and the pastures beyond them. The intensively exploited landscape of the late Early Bronze Age survives vividly in CORONA photographs.

State-Sponsored Irrigation in Ancient Assyria

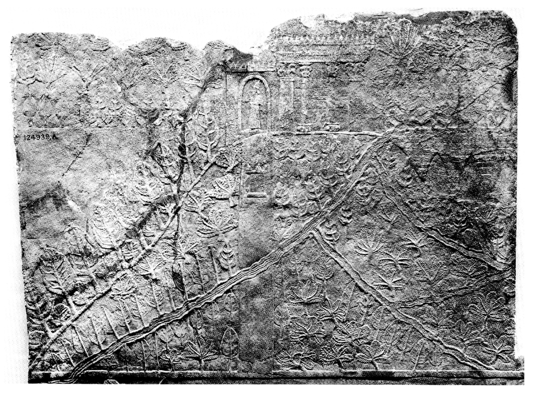

Fig. 9. Assyrian palace relief showing a garden with an irrigation channel flowing over an aqueduct.

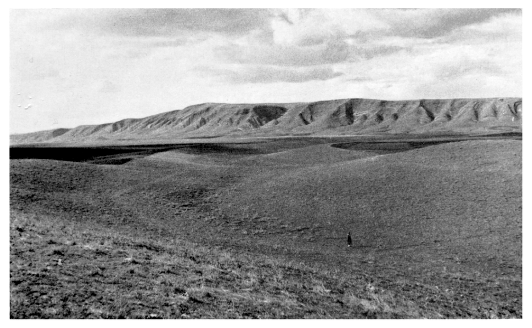

Fig. 10. Remains of the cross-watershed earthwork below Bandwai, facing NW. Oates 1968: Plate IVb.

The route systems of EBA northern Mesopotamia were not planned or constructed but rather emerged from the repeated daily movements of people and animals. Almost 2,000 years later, the irrigated landscape of the hinterland of the city of Nineveh was designed and executed in stages by the engineers of the Assyrian state (Bagg 2000, Oates 1968, Reade 1978). The irrigation canals were described in the royal inscriptions of Sennacherib (704-681 BC). Scholars have assumed that these canals brought water to Nineveh primarily to sustain the parks and gardens of the royal court (Fig. 9).

Via CORONA and other remote sensing sources, it has been possible to remap systematically this entire canal system (Ur 2005). The canals take on two distinct signatures on CORONA imagery. Large earthworks were cut through watersheds to move water between hydrologic basins. These features,

Fig. 11. The Bandwai cross-watershed earthwork. Mission 1108, Dec 6, 1969. See also Fig. 10.

which can be up to 100 m wide and 20 m deep, are still highly visible from the ground (Fig. 10), and have a dramatic signature on satellite photographs (Fig. 11). The canals which ran along the topographic contours were only 6 m wide, and are only visible with difficulty on the ground. On CORONA photographs they appear as dark lines which run parallel to the topography, unlike natural drainages (Fig. 12).

These signatures show that water was moved not only in the direction of Nineveh, but that water was removed via offtakes for use on fields at substantial distances from the royal capital. CORONA-based remapping, in combination with assessments of Sennacherib's own inscriptions, forced a reconsideration of the system as primarily for the support of elite gardens. Sennacherib's armies physically deported many conquered peoples and resettled them in Nineveh and its hinterland (Oded 1979). The irrigation system provided water to these new villages for local agriculture. In this manner, Sennacherib remade the demography and economy of northern Assyria to increase radically its agricultural output (Ur 2005, Wilkinson et al. 2005).

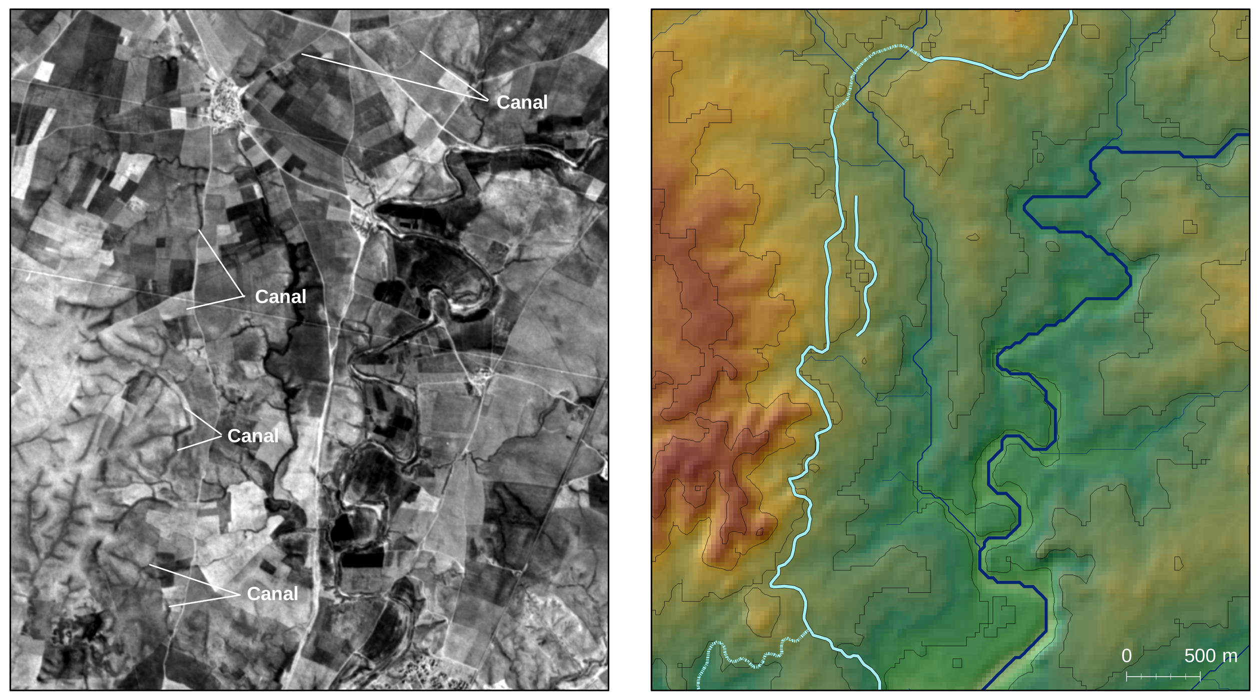

Fig. 12. Assyrian canal running parallel to topographic contours. Mission 1117, May 25, 1972. 10m contour intervals.

Agricultural Colonization under the Sasanian Empire

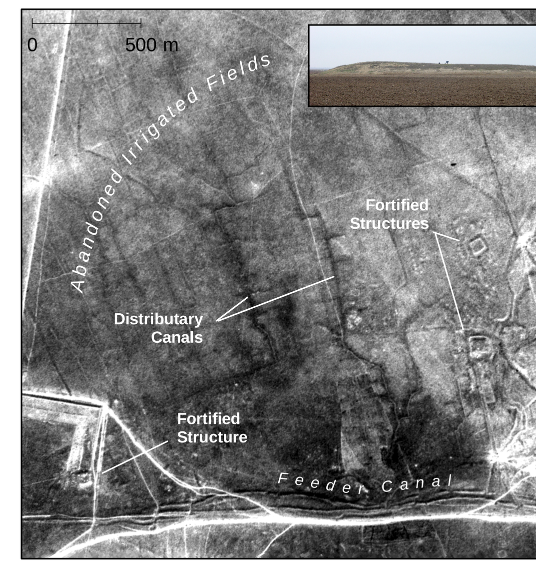

Fig. 13. Fortified structures and abandoned irrigation channels on the Mughan Steppe. Mission 1103, May 5, 1968. Inset: fortified structure from the ground.

The Sasanian empire (AD 224-630) is best known as the chief rival of Rome in the Near East. Like the Roman empire, it was expansionist and placed fortified settlements on its frontiers. Recent CORONA analysis and fieldwork have revealed a combination of fortified settlements and associated irrigation systems on the Mughan Steppe of northwestern Iran, which was formerly the frontier between Sasanian Iran and its sometime vassal state, Armenia (Alizadeh and Ur 2007, Ur and Alizadeh in press).

The landscape was composed of a string of square walled settlements along the south bank of the Aras (Araxes) River, and another along a long canal which watered the southern steppe. The signature of the main feeder canal is similar to that of the largest Assyrian canals described above. In close association with the fortified settlements were elaborate networks of distributaries and smaller branches; in some cases individual field systems can be seen (Fig. 13). Today these systems have been completely removed by a modern system installed in 1971.

Campsites and Pasturelands of the Shahsevan Nomads

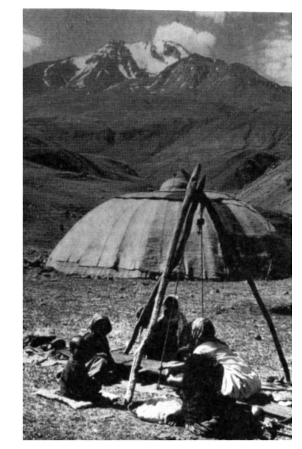

Fig. 14 Shahsevan tent.

Early in the 18th century, various Kurdish and Turkish pastoral nomadic groups in northwestern Iran coalesced into the Shahsevan tribal confederacy (Fig. 14). The Shahsevan spent their summers in pasture on Mt. Sabalan near Ardebil, and wintered on the Mughan Steppe. In 1870, it was estimated that they numbered 12,000 households, 60,000 horses and camels, and almost 2 million sheep (Tapper 1997).

In the 1960's the Shahsevan winter campsites consisted of 10-15 closely related households (Tapper 1979). Their tents leave almost no traces after being packed up, but the semi-subterranean enclosures dug for their animals do survive as shallow depressions. These can be detected on the ground but are more easily identified and mapped from CORONA photographs (Alizadeh and Ur 2007). The depressions collect moisture and vegetation and therefore appear dark; their edges appear as light circles (Fig. 15). The camps themselves have a circular layout.

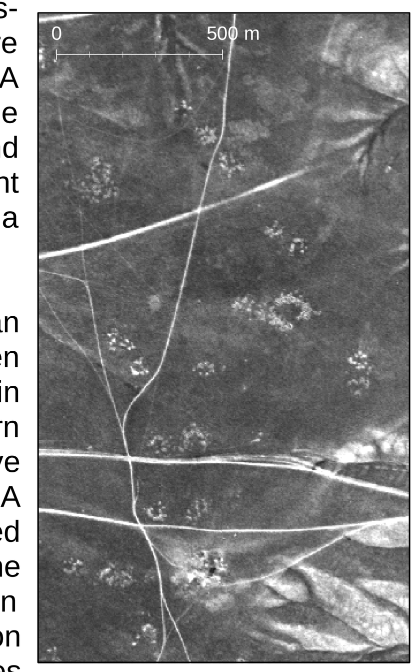

Fig. 15. Abandoned Shahsevan campsites in the Mughan

The resulting patterning shows that the Shahsevan positioned their campsites at the midpoint between upland pasture and lowland water sources within their traditional pastureholdings. The modern patterning is misleading: today campsites survive only in the uplands, but historical CORONA photographs demonstrate that they once exploited the steppe as well (the former irrigation lands of the Sasanians). Today the Shahsevan have been settled by the government, and a modern irrigation system (Schweizer 1974) has wiped out all traces of campsites in the lowlands.

Conclusions

For archaeological studies of past settlement and land use patterns, CORONA satellite photographs have proven to be revolutionary. Their high resolution (approximately 2 m in the KH-4B camera) approaches that of modern commerical satellites such as Space Imaging's Ikonos or Digital Globe's QuickBird, but at a fraction of the cost ($24/scene). Their age makes them no longer useful for their original purpose, but is highly advantageous for archaeology. Modern systems such as Landsat, ASTER, etc. image the modern landscape, but CORONA captured the landscape of the 1960's and early 1970's, before industrial agriculture and the expansion of towns and cities came to many areas of the Middle East. In some cases, all that survives of ancient landscapes are their signatures on CORONA photographs.

References

Alizadeh, K., and J. A. Ur. 2007. Formation and Destruction of Pastoral and Irrigation Landscapes on the Mughan Steppe, North-Western Iran. *Antiquity* 81.

Bagg, A. M. 2000. *Assyrische Wasserbauten: Landwirtschaftliche Wasserbauten im Kernland Assyriens zwischen der 2. Hälfte des 2. und der 1. Hälfte des 1. Jahrtausends v. Chr.* Baghdader Forschungen Band 24. Mainz am Rhein: Philipp von Zabern.

Day, D. A., J. M. Logsdon, and B. Latell. Editors. 1998. *Eye in the Sky: The Story of the CORONA Spy Satellites.* Washington and London: Smithsonian Institution Press.

Fowler, M. J. F. 2004. Archaeology through the Keyhole: The Serendipity Effect of Aerial Reconnaissance Revisited. *Interdisciplinary Science Reviews* 29:118-134.

McDonald, R. A. Editor. 1997. *Corona Between the Sun and the Earth: The First NRO Reconnaissance Eye in Space.* Bethesda: American Society for Photogrammetry and Remote Sensing.

Oates, D. 1968. *Studies in the Ancient History of Northern Iraq.* London: British Academy.

Oded, B. 1979. *Mass Deportations and Deportees in the Neo-Assyrian Empire.* Wiesbaden: Ludwig Reichert Verlag.

Reade, J. 1978. Studies in Assyrian Geography, Part I: Sennacherib and the Waters of Nineveh. *Revue d'Assyriologie et d'Archéologie Orientale* 72:47-72, 157-180.

Schweizer, G. 1974. The Aras-Moghan Development Project in Northwest Iran and the Problem of Nomad Settlement. *Applied Sciences and Development* 4:134-148.

Stein, G. J. 2004. "Structural Parameters and Sociocultural Factors in the Economic Organization of North Mesopotamian Urbanism in the Third Millennium BC," in *Archaeological Perspectives on Political Economies.* Edited by G. M. Feinman and L. M. Nicholas, pp. 61-78. Salt Lake City: University of Utah Press.

Tapper, R. 1979. *Pasture and Politics: Economics, Conflict and Ritual among Shahsevan Nomads of Northwestern Iran.* London and New York: Academic Press.

—. 1997. *Frontier Nomads of Iran.* Cambridge: Cambridge University Press.

Ur, J. A. 2003. CORONA Satellite Photography and Ancient Road Networks: A Northern Mesopotamian Case Study. *Antiquity* 77:102-115.

—. 2005. Sennacherib's Northern Assyrian Canals: New Insights from Satellite Imagery and Aerial Photography. *Iraq* 67:317-345.

—. in press. "Emergent Landscapes of Movement in Early Bronze Age Northern Mesopotamia," in *Landscapes of Movement: Paths, Trails, and Roads in Anthropological Perspective.* Edited by J. E. Snead, C. Erickson, and W. A. Darling. Philadelphia: University of Pennsylvania Museum Press.

Ur, J. A., and K. Alizadeh. in press. "The Sasanian Colonization of the Mughan Steppe, Ardebil Province, Northwestern Iran," in *Studies in Sasanian Archaeology: Economy, Industry, and Material Culture.* Edited by S. J. Simpson. London: British Museum.

Wilkinson, T. J. 1993. Linear Hollows in the Jazira, Upper Mesopotamia. *Antiquity* 67:548-562.

—. 1994. The Structure and Dynamics of Dry-Farming States in Upper Mesopotamia. *Current Anthropology* 35:483-520.

Wilkinson, T. J., E. Wilkinson, J. A. Ur, and M. Altaweel. 2005. Landscape and Settlement in the Neo-Assyrian Empire. *Bulletin of the American Schools of Oriental Research* 340:23-56.