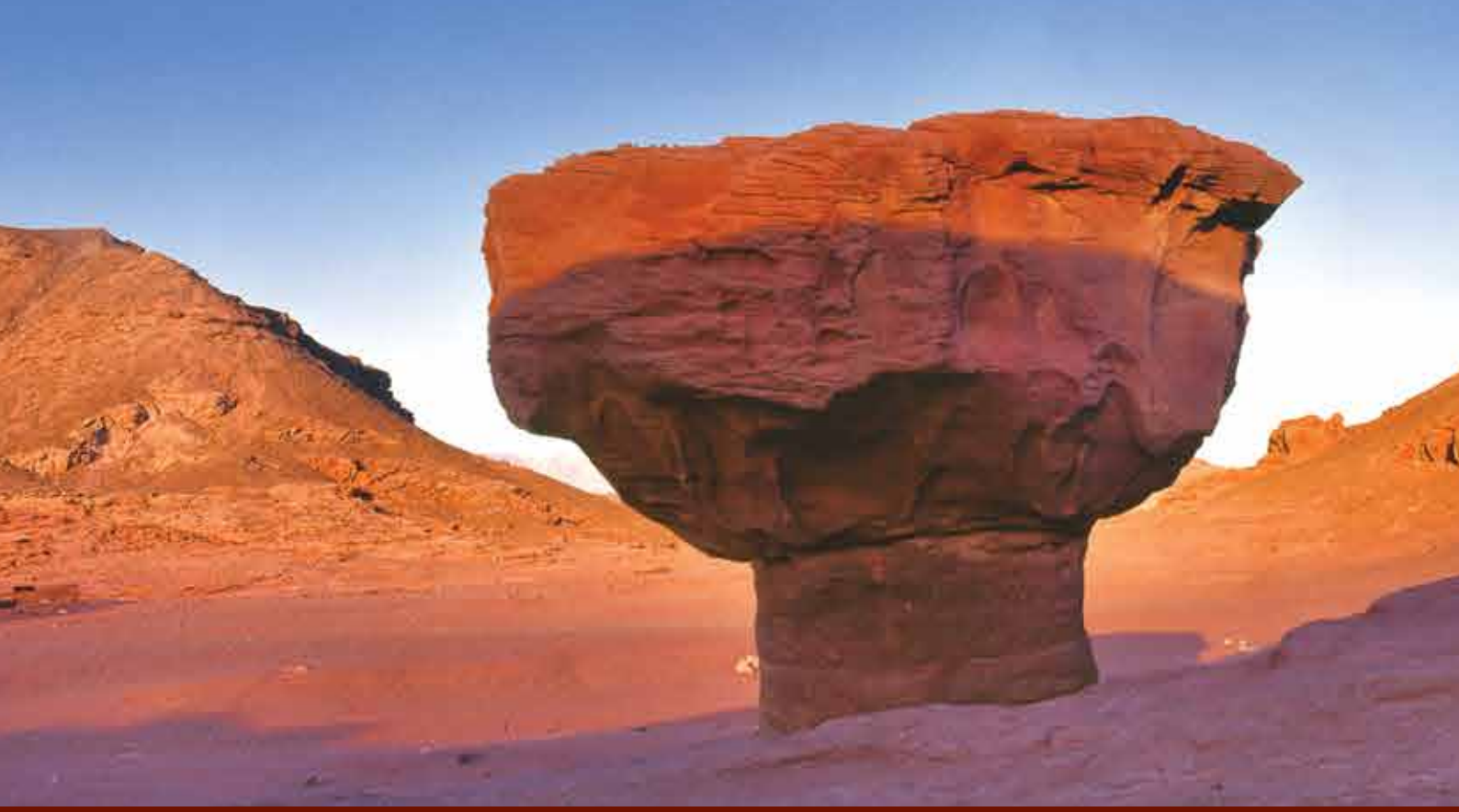

כנס פארק תמנע
לחקר תעשיות הנחושת הקדומות

Timna Park International Conference

Mining for Copper:

Environment, Culture and Copper in Antiquity

לזכרו של פרופסור בנו רותנברג
In memory of Professor Beno Rothenberg

22-25 April 2013, Timna, Israel

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פארק תמנע
Timna Park

Timna Park
International Conference

Mining for Copper:

Environment, Culture and Copper in Antiquity

In memory of Professor Beno Rothenberg

22-25 April 2013, Timna, Israel

Professor Beno Rothenberg

1914 - 2012

Program

Monday, April 22, 2013

14:30: bus shuttle from Eilat/Kibbutzim to the Timna Park

15:00-18:00 **Registration; Guided tour in the Timna Valley**

Opening event (Timna Park Visitors Center)
by invitation only

18-18:20	**Dr. Erez Ben-Yosef** *et al.* (Conference organizers)	*Rothenberg's legacy and the Timna International Conference*
18:20-18:30	**Prof. Hans-Gert Bachmann** (University College London)	*Times to Remember: My Years of Collaboration with Beno Rothenberg*
18:30-19:30	**Prof. Vasiliki Kassianidou** (University of Cyprus)	*Cypriot copper production and trade in the 13th century BCE – a technological and economic success story from the Late Bronze Age*
19:30-20:30	Opening reception	

Tuesday, April 23, 2013

(Hevel Elot Regional Council Auditorium, Yotvata)

8:00: bus shuttle from Eilat/Kibbutzim to Yotvata

Posters Presented

	Ms. Julie Goy *et al.* (University of Paris 1 Panthéon-Sorbonne)	*Archaeometallurgical research in the northern Hajjar mountains (Oman Peninsula) during the Iron Age (1250-300 BCE)*
	Ms. Ilana Peters **Dr. Erez Ben-Yosef** (Tel Aviv University)	*Timna Site 34: Applied Archaeomagnetic Experiment and Excavations*
	Mr. Robert Feather (Independent scholar)	*The Mysterious Copper Scroll*
	Ms. Ben-Dov, Rachel (Hebrew Union College)	*Craft Workshops at Tel Dan*
	Mr. Yoni Shtern (The Dead Sea-Arava Science Center)	*Timna – a UNESCO Heritage Site?*

Opening Remarks

9:00-9:20	**Mr. Dubi Goldman** Manager – Development Company – Hevel Eilot	*Welcoming address*

Session 1:

New Research at Timna and Related Issues, Part A

(Chair: Prof. T.E. Levy)

9:20-9:40	**Prof. Jim Muhly** (University of Pennsylvania)	*Beno Rothenberg and the Chronology of Copper Smelting at Timna*
9:40-10:00	**Prof. Andreas Hauptmann** (Deutsches Bergbau-Museum)	*Investigations and meaning of prehistoric Faynan and Timna in archaeometallurgy*
10:00-10:20	**Prof. John Merkel** (University College London)	*Reconsidering Timna Site 39a without Site 39b*
10:20-10:40	**Prof. Tim Shaw** (Imperial College London) **Ms. Alexandra Drenka** (Independent scholar)	*Excavations of the Sinai-Arabah Copper Age – Early Phase (Chalcolithic) Mine T in the Timna Valley*
10:40-11:00	**Dr. Lidar Sapir-Hen** **Dr. Erez Ben-Yosef** (Tel Aviv University)	*Food and culture in smelting sites: a view from Timna*
11:00-11:20	**Dr. Uzi Avner** (The Dead Sea-Arava Science Center)	*Egyptian Timna- reconsidered*
11:20-11:45	**Coffee break**	

Session 2:

New Research at Timna and Related Issues, Part B

(Chair: Prof. J.D. Muhly)

11:45-12:00	**Dr. Tali Erikson-Gini** (Israel Antiquities Authority)	*Decorated and Plain Ceramic Wares and Beads from Recent Excavations in Timna, Site 2*
11:45-12:00	**Mr. Eli Cohen-Sasson** (Ben-Gurion University)	*Recent discoveries from the Timna Valley Survey*
12:00-12:15	**Dr. Yuval Yekutieli** (Ben-Gurion University)	*Timna Chariots' Engraving - a reassessment*
12:15-12:30	**Dr. Deborah Sweeney**	*The inscription of Ramessesempere in context*
12:30-12:45	**Dr. Laura Zucconi** (Richard Stockton College)	*Transgendered Copper Mining in the Levant*
12:45-13:00	**Dr. Dan Levene** (University of Southampton)	*The rabbis' knowledge of copper alloying is implicit in laws of purity and impurity*
13:00-14:00	**Lunch break**	

Session 3:

Copper and Trade in the Southern Levant, Part A

(Chair: Prof. Sariel Shalev)

14:00-14:15	**Dr. Mordechai Haiman** (Israel Antiquities Authority)	*Copper Trade and the Rise of the Settlement in the South Levant Deserts in the Early Bronze Age IV*
14:15-14:30	**Prof. Hendrik J. Bruins** (Ben-Gurion University)	*Bronze chisel at Horvat Haluqim (central Negev Highlands) in a sequence of Late Bronze to Iron Age living floors*
14:30-14:45	**Dr. Erez Ben-Yosef** *et al* (Tel Aviv University)	*The Ashalim Site and Early Bronze Age copper production in the northern Arava*
14:45-15:00	**Ms. Yulia Gottlieb** (Tel Aviv University)	*Judah of iron vs. Israel of copper - the paradoxes of metal working development in the land of Israel*
15:00-15:15	**Dr. Mario A.S. Martin** (Tel Aviv University)	*Iron IIA Pottery from the Negev Highlands: Petrographic Investigation and Historical Implications*
15**:15-**15**:45**	**Coffee Break**	

Session 4:

Copper and Trade in the Southern Levant, Part B

(Chair: Dr. Yuval Yekutieli)

15:45-16:00	**Mr. Uri Davidovich** (The Hebrew University)	*The Late Chalcolithic copper hoard from Nahal Mishmar (Judean Desert, Israel) in a regional perspective*
16:00-16:15	**Dr. Aaron Shugar** (Buffalo State College)	*Revisiting the Nahal Mishmar Hoard's place in the Chalcolithic Near East*
16:15-16:30	**Prof. Yuval Goren** (Tel Aviv University)	*The location of Specialized Copper Production during the Chalcolithic Period as Evident from the Study of Production-Related Ceramics*
16:30-16:45	**Dr. Sari Kamil** *et al.* (Israel Antiquities Authority)	*Metal finds from Nahariyya Excavations*
16:45-17:00	**Dr. Naama Yahalom-Mack** *et al.* (The Hebrew University)	*Copper ingots from the s. Levant as indicators of diverse trade networking; a study of their chemical and isotopic composition and microstructure*
17:00-17:30	**Coffee Break**	

Session 5:

New Research at Faynan, Jordan and Related Issues

(Chair: Prof. John Merkel)

17:30-17:50	**Prof. Thomas E. Levy** (University of California, SD)	*Intensive Surveys, Large-Scale Excavation Strategies and Ancient Metallurgy in Faynan, Jordan*
17:50-18:10	**Prof. Yigal Erel** *et al.* (The Hebrew University)	*Toxic Metals in Humans in the Faynan Area*
18:10-18:30	**Ms. Christine T. Chitwood** (Andrews University)	*Iron Age copper production: a study utilizing mining and smelting activities at Timna and the Fenan Valley*
18:30-18:50	**Mr. Ian W.N. Jones** (University of California, SD)	*The 'Araba Copper Industry in the Islamic Period: The View from Faynan*
18:50-19:10	**Prof. Steven A. Rosen** (Ben-Gurion University)	*Nahal Tsafit; A Middle Timnian Site, ca. 4000 BC, on the Road from Feinan to Beersheva*

Wednesday, April 24, 2013

(Hevel Elot Regional Council Auditorium, Yotvata)

8:00: bus shuttle from Eilat/Kibbutzim to Yotvata

Session 6:

Ancient Copper Production Beyond the Southern Levant, Part A

(Chair: Prof. Vasiliki Kassianidou)

9:00-9:20	**Dr. Andreas Charalambous** (University of Cyprus)	*A Comparative Study of Cypriot Bronzes Dating to the Late Bronze and the Early Iron Age*
9:20-9:40	**Prof. Shimon Dar** (Bar-Ilan Univerisy)	*King Herod and the Copper Mines of Cyprus*
9:40-10:00	**Mr. Nathaniel Erb-Satullo** (Harvard University)	*Looking Beyond the Levant: Configurations of Copper Production in the Late Bronze Age and Early Iron Age Southern Caucasus*
10:00-10:20	**Dr. Myrto Georgakopoulou** (UCL - Qatar)	*Production of copper at different scales in the Early Bronze Age Aegean*
10:20-10:40	**Mr. R. Alan Williams** (University of Liverpool)	*The Great Orme Bronze Age Copper Mines in Wales: Ore to Metal Provenancing Opportunities*
10:40-11:10	**Coffee break**	

Session 7:

Ancient Copper Production Beyond the Southern Levant, Part B

(Chair: Dr. Aaron Shugar)

11:10-11:30	**Dr. Christopher Davey** (La Trobe University)	*Early Bronze Age refining of copper*
11:30-11:50	**Dr. Simon Timberlake** (University of Cambridge)	*Copper mining and smelting in the British Bronze Age – new evidence from mine sites including some re-analyses of dates and ore sources*
11:50-12:10	**Prof. Gert Goldenberg** *et al.* (University of Innsbruck)	*Experimental reconstruction of Bronze Age chalcopyrite smelting by employing traditional techniques from Nepal*
12:10-12:30	**Mr. Markos Vaxevanopoulos** *et al.* (Aristotle University of Thessaloniki, Greece)	*Ancient mining in gold-silver-copper deposits and metallurgical activity in Mavrokorfi area, Pangaeon mount (NE Greece)*
12:30-12:50	**Mr. Marcin Czarnowicz** (Jagiellonian University, Krakow)	*The role of copper tools in early Egyptian society: the case study of Tell el-Farkha copper objects assemblage*
12:50-13:10	**Mr. Frederik Rademakers** *et al.* (University College, London)	*Bronze production in Pi-Ramesse: Alloying technology and material use*
13:10-14:00	**Lunch break**	

Session 8:

Geology of the Arava Copper Ore Districts and Regional Tourism

(Chair: Prof. Steve Rosen)

14:00-14:20	**Dr. Michael Beyth** *et al.* (Geological Survey of Israel)	*Stratigraphy, structure and copper mineralogy of the Timna Valley*
14:20-14:40	**Mr. Moritz Jansen** *et al.* (Deutsches Bergbau-Museum)	*The differentiation of ancient copper from Timna and Faynan through stable Cu isotopes*
14:40-15:10	**Dr. Hanan Ginat** (The Dead Sea-Arava Science Center) **Mr. Assaf Holzer** (Timna Park)	*Copper and Environment in Timna as a platform for Earth Sciences, Archeology Study and Tourist Programs*
15:10-15:20	**Coffee Break**	

Session 9:

New Research at Nahal Amram, Israel

(Chair: Dr. Uzi Avner)

15:20-15:30	**Dr. Uzi Avner** *et al.* (The Dead Sea-Arava Science Center)	*Renewed Research in the Area of Nahal Amram, Southern Araba*
15:30-15:45	**Prof. Amos Frumkin** *et al.* (The Hebrew University)	*The Amram Valley, Israel: A survey of Underground Copper Mines*
15:45-16:00	**Dr. Hanan Ginat** (The Dead Sea-Arava Science Center)	*Evidence of floods in the Amram copper mines*
16:00-16:15	**Prof. Sagi Filin** *et al.* (Technion, Israel)	*Volume and mass estimation of mine dumps and slag heaps using high-resolution terrestrial laser scans*
16:15-16:30	**Dr. Uri Bason** (GeoSense Ltd)	*Detecting ancient copper mining shafts and depth of mine-dumps using geophysical methods: Nahal Amram and Timna, southern Arava*
16:30-16:45	**Prof. Sariel Shalev** *et al.* (Haifa University)	*Compositional Analysis of Slags from Nahal Amram*
16:45-18:30	**Guided Tour to Nahal Amram**	
18:30-19:00	**Closing Reception in Eilat [by invitation only]**	

Thursday, April 25, 2013

(Wadi Faynan, Jordan)

5:50: bus shuttle from Eilat/Kibbutzim to Yitzhak Rabin Border Crossing

Visiting Wadi Faynan Copper Ore District

All Day (6:30 border crossing)	**Prof. Andreas Hauptmann** **Prof. Thomas E. Levy** **Dr. Mohammad Najjar** **Dr. Erez Ben-Yosef**	Guided Tour to Faynan, Jordan

The Timna International Conference in Memory of Professor Beno Rothenberg

There is no better place to honor Beno Rothenberg's work than the Timna Valley, the center of his interdisciplinary research for decades. Fifty four years ago Rothenberg pioneered the systematic study of ancient copper metallurgy in Timna, together with a dedicated group of scholars from various academic fields. This work was part of the first steps of a new sub-field of archaeological research: archaeo-metallurgy, the study of ancient metals and metallurgical technologies. Rothenberg's work in Timna is the background for the main theme of the conference – copper in antiquity, and his recognition of the importance of collaborative research is the background for the wide scope of topics, which include archaeology of technology, of cultures and societies as well as textual studies and research of the physical environment that dictated human activities around copper ore deposits throughout the millennia.

Located in the southern Negev desert of Israel, Timna Valley hosts some of the best preserved ancient copper mining and smelting sites in the world. This in itself makes the place a perfect venue for the conference, enabling us to include professional tours to key sites where active research is currently taking place. In addition to the Timna Park itself, the conference includes a short tour to the copper mines of Nahal Amram located to the south, and a comprehensive tour to Timna's northern counterpart in Jordan, the Wadi Faynan copper ore district. This is indeed a unique opportunity to get updated on research on both sides of the modern border between Israel and Jordan, and to discuss ancient copper exploitation along the geographic unit of the Arava Valley as a whole.

Several sessions of the conference are dedicated to new developments in research of primary production sites along the Arava Valley (Timna, Amram and Faynan). These are complemented by sessions concerned with copper artifacts and trade in the southern Levant. In addition, a few sessions extend the scope of the discussion to copper related issues beyond the southern Levant, including Cyprus, Egypt, Greece and England as well as several aspects that cut-across the Ancient Near East. The variety of presentations emphasizes the richness, complexity and wide implications of the conference theme, qualities that Rothenberg have noticed early on in his research.

The Timna International Conference came to fruition as a result of dedicated work and support of many people and institutions. First are the contributors, which include more than 80 scholars from 14 different countries (among them several of Rothenberg's old team members and students), who made the effort to attend this rather isolated venue and share their research. The conference could not have succeeded without its host, the Timna Park, whose manager, Ms. Hagit Gal, made every effort to facilitate the quite complicated logistics. The academic sponsorship was given by Tel Aviv University, including support of the Vice Presidents, the Institution of Archaeology and the graduate program in archaeomaterials. Academic and financial support was also provided by The Dead Sea-Arava Science Center and the Institute of Arhcaeometallurgical Studies (IAMS) at the University College, London. The latter was established by Rothenberg and served as his academic home for many years. The conference was also supported by the following institutions: Hevel Eilot Regional Council, KKL - The Jewish National Fund, the Israel Government Tourist Corporation and Eretz Israel Museum in Tel Aviv. It is also the place to acknowledge several individuals who contributed in various ways: Ms. Judith Gavish and Dr. Dan Levene for contribution of the books 'A Metallurgical Gemara' to presenters, Ms. Danit Galler for help with design of conference materials, Ms. Hila Baharian and Mr. Craig Smitheram for help with administration, and Ms. Lana Chernishova for coordinating the Faynan tour.

Rothenberg always felt at home in Timna, discovering something new in the archaeologically-rich landscape in every visit, and adding new insights into the culture and history of humankind's exploitation of its limited natural resources. We believe he would have been proud to attend this conference and to meet his old colleagues, his students, and a substantial new generation of young scholars who follow his legacy. Even though it is a short visit, we hope you also feel here, in Timna, at home.

Tel Aviv/Timna, April 2013
Dr. Erez Ben-Yosef *(Tel Aviv University)*
Dr. Hanan Ginat *(Dead Sea-Arava Science Center)*
Prof. Yuval Goren *(Tel Aviv University)*
Mr. Assaf Holzer *(Park Timna)*

In Memoriam: Professor Beno Rothenberg

(first published in 2012 in *Israel Exploration Journal* 62(1):244-246)

PROFESSOR BENO ROTHENBERG, a pioneer in archaeo-metallurgical studies and the excavator of Timna, passed away peacefully on March 13, 2012, in his home at Ramat Gan at the age of 98.

Although never completely embraced by the archaeological community in Israel, Beno Rothenberg's contributions to the field were outstanding. Indeed, hehelped place the young country at the forefront of two budding sub-fields of archaeological research: the study of ancient metals (with a focus on evolution of production technologies) and the multidisciplinary approach dedicated to the application of analytical methods from the natural and exact sciences in archaeological studies (broadly termed 'archaeometry'). It was, in fact, Rothenberg who coined the term 'archaeo-metallurgy', now a common title for a well-established discipline.

Born in Frankfurt in 1914, Beno Rothenberg immigrated with his family to Tel Aviv in 1933. His academic training was in the fields of mathematics and philosophy, studying at the Hebrew University of Jerusalem and at the University of Frankfurt, where he received his Ph.D. in 1961. Prior to his engagement in archaeology, Rothenberg published several important articles in philosophy, as well as a book of poetry. After buying his own camera in 1945, Rothenberg became a passionate photographer, and he gained fame as one of the most prominent photographers of the early stages of the State of Israel.

Photography was what drew Rothenberg to archaeology. In the early 1950s, he was the photographer of the archaeological expeditions of the Jewish American archaeologist Nelson Glueck to the Negev; Rothenberg was promoted to expedition supervisor and became an administrator of the field team. In these positions and with Glueck's support, he developed the skills that allowed him to embark on his own archaeological projects, beginning with a survey of the Sinai Peninsula in 1956. More or less concurrently with his work with Glueck's expeditions, Rothenberg became a protégé of Yohanan Aharoni through their work in the Judaean Desert. Aharoni's support became an important asset to Rothenberg in the 1960s, when Rothenberg's new research trajectory led to scholarly collisions with Glueck and other prominent biblical archaeologists over the interpretation of archaeological data and biblical texts.

The desert landscapes of southern Israel were the focus of Rothenberg's research for several decades. The stark images of the harsh empty land are sprinkled throughout his publications. His popular books are beautiful syntheses of photo albums, stories from the bonfire of various research expeditions, and vivid descriptions of scientific discoveries. Rothenberg's enthusiasm for archaeological exploration blended with his artistic bent and appreciation of aesthetics, a combination that made his research colourful and attractive to layman and scholar alike; this was the grain around which his archaeological practice was centred, a distilled form of the archaeological endeavour in itself.

The romantic air of Rothenberg's early explorations in the wilderness of southern Israel did not affect the objectivity of his interpretations, and he stuck to field evidence even in a period soaked with biblical literalism in archaeological research. With strict adherence to the facts on the ground, Rothenberg replaced Glueck's 'Solomon's Mines' at Timna with an interpretation of Egyptian-controlled mines after the discovery of the Hathor Temple. Years later, when I sat in his cozy apartment and introduced him to new analytic data which negated some of his previous chronological conclusions (Sites F2 and 30), he again hewed close to the scientific evidence and wholeheartedly (and graciously) accepted the revisions. More than that, he welcomed the new research methods, saying: 'We did the best we could with the methods then available to us'. Not content with the standard archaeological practice of his days, Rothenberg realized the importance of collaborating with scientists of other fields, and he included geologists and material engineers in his team of the 'Arava Expedition' to aid in the excavations at the ancient copper mines and smelting sites of Timna. Consequently, Rothenberg was the first to locate the ancient mine shafts and galleries and the first to correctly interpret the various metallurgical remains, including installations that were entirely misunderstood by earlier scholars. Rothenberg's discoveries at Timna, one of the best preserved ancient metal-production regions in the world, prompted him to

establish the first research institution devoted to archaeo-metallurgical studies (Institute for Archaeo-Metallurgical Studies [IAMS]) in 1973. His connections with Tel Aviv University and his long-lasting affiliation with the Eretz Israel Museum (the home of the 'Arava Expedition' for many years) did not yield a permanent position, and he chose the University of London as the home of the new institution, still one of the leading research units of its kind in the world. Nevertheless, Rothenberg, devoted to Israel, continued to live and work in the country, limiting his travels to Europe to the minimum necessary.

Beno Rothenberg's work in the Arava has culminated in two seminal publications: the final report of the excavations at the Hathor Temple in Timna (IAMS 1988), an extraordinarily rich (over 11,000 small finds) sanctuary, dated to the late fourteenth–mid-twelfth centuries BCE, and the detailed presentation and analysis of copper-smelting related artefacts throughout the millennia in *The Ancient Metallurgy of Copper* (IAMS 1990). The extensive surveys conducted by Rothenberg in the Negev and in the Sinai Peninsula still await final publication (the material is now with the Israel Antiquities Authority).

In addition to his research in the Arava Valley and the Sinai Peninsula, Rothenberg's main archaeological achievements were his studies at the Phoenician and Roman silver-production sites of Rio Tinto and Huelva in Spain. Although some of the material from Rothenberg's work in these regions did not see final publication, the data published constitute an invaluable source of information on ancient metallurgy and remain a basic reference in modern research. In both regions, Rothenberg had students working on various aspects of ancient metallurgy; some became prominent scholars working today in the U.K., Cyprus, Spain, the U.S. and Germany.

Leaving behind an important legacy, Beno Rothenberg had an impact on the archaeology of Israel and its place in the global archaeological scene. Although some of his interpretations have been contested, Rothenberg was a visionary archaeologist who understood the importance of ancient metallurgy as key to a better understanding of past human societies and considered the archaeology of the copper ore districts of the southern Levant to constitute an invaluable source for research into the interactions of humans with their natural environment. As Rothenberg himself put it, Timna is the best field laboratory for archaeo-metallurgy studies.

Beno Rothenberg's seeds, sown in a rugged and not always welcoming land, have already demonstrated their potential in various ways. It is now up to us to protect and further cultivate what Rothenberg has built, to continue where he left off, and to integrate his approach and fundamental fields of research into the archaeological practice in Israel, the country that became his only home.

EREZ BEN-YOSEF

Times to Remember by Hans-Gert Bachmann

On August 15th in 1959 the Frankfurter Allgemeine, a leading German newspaper, published an article by Beno Rothenberg under the title König Salomons Kupfergruben (King Solomon's Copper Mines). At about the same time I received a piece of ancient copper slag from the region, where Solomon's mines and smelters were supposed to be situated, i. e. in the Southern Negev in Israel with the place name Timna. The donor, the epigrapher Friedrich Karl Dörner from Münster University / Germany, with whom I had worked previously in Eastern Turkey, knew about my keen interest in relics of ancient metallurgical activities, e.g. slags. The sample was investigated and characterised with regard to chemical and phase composition. It proved to be a surprising witness of efficient process technology dating to the first millennium BC. Assuming these results to be of interest to the author of the article mentioned above, I approached the newspaper's office to give me Rothenberg's address. Thus, a first contact between us was established and in due course a personal meeting in Frankfurt was arranged. By then I had learned the author came from a well-known Jewish family in that city. They had left Germany in the early thirties of the last century. Of course, Beno Rothenberg had ample support in his researches by qualified colleagues in Israel and elsewhere. Nevertheless my small contributions were appreciated.

Until autumn of 1971 Rothenberg's surveys and trial excavations in the Timna area had revealed sensational results and finds. Much regretted by Israeli archaeologist, they were subsequently deprived of apparent facts of Biblical evidence, because new research and dates indicated that the Southern Negev was no longer the

site of King Solomon's mines and smelters, but witness of successful Egyptian (sic) expeditions and activities, dating to the 11./12. century BC (i.e. Egyptian New Kingdom) on territories which are now part of Eretz Israel. Beno decided to present his new discoveries at an exhibition in the British Museum in 1971 under the cautious heading: "Midianite. Timna; Valley of the Biblical Copper Mines". I was invited to attend the opening and even my name appeared in the small catalogue. It was the official starting point of an affiliation which lasted more than half a century. Our common fields of interest proved to be of mutual benefit. Beno used his good relations and connections with the universities of Frankfurt/Main, Germany, and London which resulted in teaching appointments and I could help to establish links with the German Mining Museum at Bochum and the generous Volkswagen Foundation, which just at this time had inaugurated a new funding project in archaeometallurgy. The Timna exhibition was – after London – subsequently shown at several museums in Germany. As a result, the German Mining Museum participated in the Timna-Arabah- Expedition. The newly founded Institute of Archaeometallurgical Studies (IAMS) became attached to the Institute of Archaeology of the University College London.

At last, Timna became a reality for me in 1972. I was asked to participate in excavations in the Negev and in surveys of the Sinai Peninsula, at that time under Israeli occupation. Hot and strenuous days with discoveries of new sites wherever we walked or drove,were followed by silent, chilly nights under the starry skies, wrapped-up in our sleeping bags, spread out on the still warm sand. The crates with our provisions contained such interesting items as pickled baby egg-plants. They became ingredients of a stew (tschorba = Arabic for soup), which I was permitted to heat, being the "shabbes goi", who as a gentile could light a petrol stove on a "Shabbat".

Beno was a born leader and ran a team of a dozen or more different (and sometimes difficult) members, ranging from Kibbuz volunteers to senior scientists, most efficiently. Due to his authority, experience and knowledge his position was never challenged. Rumours that he once was a high-ranking army officer were neither confirmed nor demented. He probably belonged to the paramount group of Israeli military officers turned into archaeologists or vice versa, like e.g. Moshe Dajan and Yigael Yadin. Beno could sometimes be demanding, but it always served a common interest and cause. Our colleague, the late R.F. (Ronnie) Tylecote brought it to a point: "Let's keep Beno happy, as long as he doesn't step on our toes."

Challenges and experiences in the field were repeated for me in 1974, 1976 and 1978. Henceforth, I was invited several times to Israel. In 2000 I had the honour to present an homage to Beno at the Yad Ben Zwi–Institute, Jerusalem. My contribution was announced under the heading "Timna and Beyond". The following day, Beno drove me through the Judean Mountains to Jericho and to see what was left of the excavations of Kathleen Kanyon, the renowned Biblical archaeologist. Until 2005, we met annually in London to give our lectures to students from many countries and continents attending the IAMS-Summer-School at the Institute of Archaeology.

On 13 March 2012, Beno Rothenberg died in Ramat Gan/ Tel Aviv at the Biblical age of 97. He has left us this legacy: To continue where he had begun.

Fig. 1: Beno Rothenberg opening the Timna Exhibition at the British Museum, October 1971.

Fig. 2: Beno Rothenberg at the entrance to a turquoise mine at Serabit el-Khadim/Sinai, April 1974.

Following Rothenberg's Legacy: The Central Timna Valley Project

By Dr. Erez Ben-Yosef

www.archaeology.tau.ac.il/?projection=timna-valley-project

Commenced in 2012, the Central Timna Valley (CTV) Project of Tel Aviv University is a multi-year multidisciplinary research that follows Rothenberg's attempt to elucidate various aspects of the archaeological record in the vicinity of the copper ore deposits of the southern Arava. The first phase of the project includes new excavations and surveys designed to address a number of critical issues in the Late Bronze and Iron Age archaeology of the southern Levant. These include the history of copper production technology and the introduction of iron, historical issues concerning the nature of 13th – 9th c. BCE desert societies and the impact of the intense copper production on social processes, regional and global political interactions and the economy of the southern Levant at that period.

The focus of the first field seasons has been Site 34 ("The Slaves' Hill" / "Giv'at Ha'avadim"), one of the largest smelting camps in the Timna Valley, in addition to two mining fields near the Merkavot Site that represent the two common types of mines in the region: shafts & galleries and open pits. One of the biggest challenges of the new project is the question of chronology. As recent research at Site 30 clearly demonstrated (Ben-Yosef et al. 2012), the previously accepted 'Egyptian paradigm', according to which the main sites in the valley should be dated to the Late Bronze Age – Egyptian New Kingdom period, is no longer valid. Site 30 is now dated to the early Iron Age (11th – 9th c. BCE) and the date of the other main smelting camps, as well as the thousands of mine shafts, is now insecure. In order to address this problem we apply high resolution radiocarbon dating to short lived organic samples from the smelting sites and OSL dating to sediments in the mines. Both methods are promising, as the preservation of organic materials in the arid environment of Timna is extraordinary and the sediments blocking the mine shafts are mostly fine grained quartz, a suitable material for OSL experiments.

Site 34 was previously surveyed by Nelson Glueck (1934) and the Arava Expedition of Rothenberg (1959-1961), but it is only now that the first detailed mapping and systematic excavations take place. When asked why he did not conduct excavations at this key site in the center of the Timna Valley, Rothenberg argued that it was kept for the next generation, to be investigated using new methods and different methodologies. Indeed, the design of the CTV Project is a consequence of this visionary approach.

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New excavations at Site 34 – "the Slaves' Hill" – February 2013

Abstracts

Egyptian Timna Reconsidered

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In the early stage of research (1934), Timna Valley was identified by N. Glueck as a Solomonic copper mining center. In 1969, following the excavation of the Egyptian Temple by B. Rothenberg, the entire complex of mines and smelting camps was attributed to the New Kingdom Egyptian pharaohs, from Ramesses II to Ramesses V. (*ca*. 1280-1150). Since then, Timna Valley is often referred to as the finest example for New Kingdom Egyptian technology of mining and metallurgy.

Today, a reexamination of the Timna research results prompts a different historical-social-technological picture:

First, analysis of publications of the Egyptian Temple indicates that originally it was a typical local, desert shrine. The Egyptians added a "chapel" for the goddess Hathor, next to the local gods, represented by *masseboth.* The cult of desert gods was practiced here before the arrival of the Egyptians, during their stay and after they left.

Second, no Timna type mines-, *i.e.* deep, narrow shafts and horizontal galleries- were ever published from Egypt. On the other hand, these advanced mines were actually the result of a long and gradual local development, beginning in the Chalcolithic period or even earlier.

Third, no furnace remains similar to those of Timna were discovered in Egypt, and no New Kingdom smelting furnace of any kind was ever published from Egypt. Therefore, the Timna furnaces cannot be identified as Egyptian. More so, all ^{14}C dates from the furnaces excavated at Timna, Nahal Amram and Be'er Ora, fall within the Early Islamic Period (7th-8th centuries AD). Presently, no furnace in the entire Araba Valley can be termed "Egyptian".

Forth, ^{14}C dates compiled from Timna and other copper production sites along the Araba Valley, indicates that the peak of copper production in that region was during the 10th-9th centuries BC, after the cease of Egyptian presence at Timna. Unavoidably, this activity must be linked to the local desert population.

The question now is, what was the role of the Egyptians and what was the role of the local desert tribes in the copper production at Timna?

A possible answer will be addressed in the lecture.

Renewed Research in The Area of Nahal Amram, Southern Araba

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This presentation serves as an introduction to the following lectures, presented by the above members of the research group.

Nahal Amram, 10 km north of Eilat, is an area with a rich, varying lithology and a complex geology, influenced by the adjacent Syrian-African Fault. Copper bearing sandstones are exposed here, among other rock formations. During the 1960s, the area was surveyed by B. Rothenberg and in 1989 some copper mines were documented in detail by L. Willis, under Rothenberg's instructions. In 2010, a new, multidisciplinary research was begun by the above colleagues, supported by the Israel Ministry of Science.

Of the Neolithic Period, nine cult sites were found situated around the mining area. Some of them contained copper nodules indicating interest and gathering of copper nodules as early as the 8th millennia BC. Exploitation of copper for metal production appears to have started during the Chalcolithic Period (4500-3500 BC). Evidence for this period is currently limited to a few small habitations with some flint and pottery. However, Nahal Amram should be viewed as the closest large copper source to the two Chalcolithic villages in Aqaba, Tell Magass and Tell Hujayrat al-Ghuzlan, with intensive copper industry.

The next period of copper mining and smelting was the Late Bronze and Iron Age (13th to 9th centuries BC). A large

miners camp from these periods has been documented, with 160 stone-built hut bases and many stone tools, pottery sherds and furnace slag. Two mining methods were employed in this period. One was depressions dug into the alluvial terraces, 324 were mapped around the miners camp. The second was narrow shafts and galleries, 36 shafts and 28 horizontal galleries penetrating the rock escarpments were recorded.

Another period of copper exploitation was the Nabataean. Until recently, this period was only known here from a small amount of pottery sherds and one important rock carving. However, three ^{14}C dates recently received from two mines and one mine-dump were all *ca*. 240 AD, *i.e.* the Late Roman Period but with no Roman presence in the Negev. Mining during this period was based on long galleries, leaving mining dumps on the slopes. The extent of the mines cannot be determined today due to intensive mining during the following period.

A major period of mining at Nahal Amram was the Early Islamic (7th-11th centuries AD), when the mines reached their maximum dimensions, based on broad, long galleries and halls. To date, 32 mine entrances were recorded, the largest mine has a total length of 1160 m of galleries and halls. Most of the pottery sherds found in the mines and dumps are early Islamic. A furnace next to a small pile of copper slag also belongs to this period. Recent excavation inside the largest mine yielded a wide array of finds (to be presented). The Nabataean and Early Islamic period mines produced over 40,000 tons of dump.

The large scale of the the Early Islamic mines at Nahal Amram stands in contrast to the small pile of slag, estimated at only 80 tons which represent production of only 4-6 tons of copper. Therefore, most of the copper was smelted elsewhere. Indeed, several larger smelting camps of the period are known in the southern Araba, the primary one is near Be'er Ora, close to a water source. Two Mamlukian buildings at Nahal Amram, two in Timna and one ^{14}C date from Be'er Ora indicate continuation of copper mining during this period as well.

The temporary results of the renewed research at Nahal Amram demonstrate that there is still much to study about the ancient technology of copper mining and smelting, and about the role of copper in the history, economy, sociology and politics of desert.

Detecting Ancient Copper Mining Shafts and Depth Of Mine-Dumps Using Geophysical Methods: Nahal Amram And Timna, Southern Arava

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The Nahal Amram and Timna areas, 10 and 30 km north of Eilat, contain a rich, varying lithology and a complex geology, affected by the adjacent Arava rift valley. Copper bearing sandstone, among other rock formations, attracted various cultures, beginning with copper nodules gathering in the Early Neolithic Period, continuing with copper mining and smelting during Chalcolithic and Early Bronze, the Middle Bronze Age (at Be'er Ora) Late Bronze and Iron Age, Nabataean-Late Roman, Early Islamic and the Mamlukian Period.

In both mining areas many "plates" are known (shallow circular depression on the surface, 2-5 m across). In Timna Valley, they are identified as deep, filled-in mining shafts penetrating the alluvium and the copper bearing sandstones. At Nahal Amram, they may be either deep mining shafts or shallow probes for detecting copper nodules from the alluvium. In order to verify this possibility, and to measure thickness of mine-dumps for volume calculations, near-surface geophysical investigation was conducted. We used two orthogonal electromagnetic methods - Ground Penetrating Radar (GPR) and Frequency Domain ElectroMagnetic (FDEM), which are widely used for subsurface imaging in geophysics.

GPR methods use high-frequency (MHz-GHz) electromagnetic waves to image the subsurface by transmitting radar pulses into the ground and receiving a returned signal from interfaces below. Radar reflections, which are mainly a function of changes in dielectric constants, are gathered to an image, which can be analyzed for its derived electrical properties and subsurface characteristics. FDEM systems create low-multi-frequency (Hz-kHz) varying magnetic fields inducted into the ground and creating eddy currents and secondary magnetic fields.

Thereby, they enable measurement of the apparent fields of electrical conductivity and magnetic susceptibility. The combination of these two methods enable detecting and mapping different layers, subsurface discontinuities, voids, density changes and more. It increases the possibilities of detection and enhance the validity of the results.

In the lecture we will present the physical principles of GPR and FDEM and the methods imaging and interpretation of shafts, depressions and dumps at Timna and Nahal Amram.

Craft Workshops at Tel Dan

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The southern flanks of Tel Dan served over various periods as an industrial area allocated to storage and crafts. In the strata dating to the beginning of the Iron Age, a quarter covering an area of 20x35 m consisting of structures surrounded by courtyards, was exposed. It yielded numerous installation and artifacts attesting to metallurgical activity. These remains allow us to examine and reconstruct an aspect of the daily life of Dan's inhabitants in antiquity.

The aim of the following discussion is to present the nature of the activities carried out in the area and to examine the function of every installation, tool, and other objects involved.

The metallurgical activities were conducted in courtyards that contained a range of installations and furnaces: some stone-built, others dug into the ground. Inside and around the installations were pounders and large stones of vesicular basalt, that saved as a working surfaces, crucibles with slag adhering to their bottoms, bronze and iron slag, tuyères, fragments of metal and bone objects, pot bellows, burnt wood, olive pits, pottery vessels, an abundance of animal bones, deposits of charcoal over small ash pits, a large concentration flint, and fragments of brittle clay, worked and smoothed on the interior, perhaps attesting to moulds that had crumbled.

The majority of the ceramic assemblage consists of: chalices, their bowls scorched on the inside; stands; and cooking pots. Large thick-walled kraters and pithoi were sunken into the ground in the corners of rooms.

Broken metal implements and scraps were melted down in the crucibles and recycled. The pottery assemblage from the workshop district is examined with the aim of determining the function of each vessel and other items in the industrial processes.

Analysis of slag and bronze artifacts revealed that in most cases the source of the copper used in their manufacture was Timna or Faynan.

The Ashalim Site And Early Bronze Age Copper Production In The Northern Arava

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Located west of the Dead Sea, the Ashalim Site is the northernmost primary copper production site known today in the southern Levant. The site, discovered in 2002 by Y. Israel and reported briefly by U. Avner in the same year, is dominated by numerous lines of standing stones (Masseboth) and other enigmatic architectural installations. Small black solid slag fragments are scattered between the stone features in the central part of the site, representing smelting activity probably from ore transported from the nearest deposits in Faynan, ca. 40 km to the southeast. We conducted a detailed survey in 2010 that yielded no typologically datable materials (and no pottery sherds). Thus, to constrain the date of the metallurgical activities at the site, we measured geomagnetic intensity values recorded in the slag at the time of its cooling. These values were compared to the archaeomagnetic intensity curve of the Levant, as well as to intensity values obtained from slag of well-dated contexts in Faynan (the well-studied, stratified copper production site of Khirbat Hamra Ifdan). The results show that copper smelting at the Ashalim Site took place during the Early Bronze Age IV (ca. 2200 – 2000 BCE), a period of significant smelting in Faynan and active trade of copper ingots across the Negev.

In addition to slag samples from Ashalim Site, we measured intensity values of slag from the sites of 'Ein Yahav and Hazeva situated south of the Dead Sea, along the western margin of the northern Arava valley. The intensity values indicate smelting activities there during the EBIII (ca. 2600 – 2200 BCE). The new results, together with previously published data on Early Bronze Age copper smelting and trade in the southern Levant (and especially Faynan), are the basis for a discussion on the organization of production and its socio-political background during the 3rd millennium BCE, when urbanism first arose and then collapsed in this region of the Ancient Near East.

Stratigraphy and Structure of the Timna Valley

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The Timna Valley(TV), 9 × 10 km^2 in size, is a domal structure, semi-crater shaped valley, truncated in the east by the Dead Sea Transform (DST) and surrounded by a 500-m-high sedimentary sequence of Cambrian and Cretaceous age. The core of the TV is the high structural block of Mt. Timna (5 × 3 km in size, 453 m.a.s.l which is the highest topographic feature in the TV) a shallow intrusive complex of Neoproterozoic age and is the northernmost tip of the Arabian–Nubian shield Uplift and peneplanation during the Early Cambrian marked the final cessation of the Neoproterozoic East African Orogen (EAO). Early Cambrian sedimentation began with fluviatile subarkoses of the Amudei Shlomo Formation, which is overlain by dolostones, sandstones, and siltstones of the Timna Formation, representing a marine ingression of the Middle Cambrian age. The continental, Middle Cambrian subarkoses and siltstones of the Shehoret Formation overlie this marine unit. Lower Cretaceous quartz-arenites of the Amir, Avrona, and Samar formations are conformably overlie the Cambrian sequence . In the northern Timna Valley the Cambrian Formation and the Lower Cretaceous Amir and Avrona formations are cut by a basaltic plug and funnel-shaped vents with volcaniclastic fill of Early Cretaceous age . The Lower Cretaceous clastic units are covered by a thick series of platform carbonates (Judea Group), which build the upper part of the escarpment surrounding the Timna Valley .

The regional water divide runs along the summits of the western cliffs of the TV. It separates between steep, short channels that drain the cliffs eastward from the wide, moderate gradient streams that drain the elevated areas westward. The TV is drained by two ephemeral streams: Nahal Timna to the north of Mt. Timna, which flows in an E-W striking graben, and Nahal Nehushtan to the south of Mt. Timna. These drainage systems flow eastwards to the DST, where their flow direction shifts northward toward the Yotvata Playa , an internal base level for the surrounding region within the DST. The present climate in the TV is extremely arid, with short rain events and an average annual rainfall of 25 mm/yr.

The major structural feature controlling the region is the DST, which is an active plate boundary, separating the Arabian plate from the Sinai sub-plate. Tectonic activity in this rift includes sinistral faulting and rifting . Feinan the ancient copper mine on the eastern margins of the DST was separated from the TV on the western margins 105 km by this sinistral movement .

In the Arava Valley the DST is composed of a series of en-echelon strike-slip faults, which form structural and topographical basins . The Yotvata Playa, the base level for the TV streams, is the deepest basin in the southern Arava, filled by more than 1200 m of young sediments .

Tectonic activity along the DST combined with displacement of the E-W oriented dextral strike slip of the Themed fault, located 8 km south of Mt. Timna controlled its uplift. Mt. Timna has a polygon shape surrounded by reverse faults striking NNE on the northwest and the southeast sides and normal faults striking WNW of the Timna Graben on the northeast side and along the faults of the Arava margins that strike NEN .

The copper-manganese mineralization took place in four cycles controlled by the stratigraphic and tectonic evolution. The copper in ancient times was mined from the Lower Cretaceous, top Amir Fm. and base A'vrona Fm. in the Timna Valley and from the equivalent of the Cambrian Timna Fm. in Feinan, manifesting the most ancient metallurgy industry in the Middle East .

Bronze Chisel At Horvat Haluqim (Central Negev Highlands) In a Sequence Of Late Bronze To Iron Age Living Floors

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The site of Horvat Haluqim is situated in the central Negev Highlands, north-east of Kibbutz Sede Boker. Cohen excavated the site during 1971-72 and most building remains were dated by him to Iron Age II, attributed to the 10th century BCE. Extensive surveys and excavations in the central Negev during the 1980s and 1990s convinced Cohen and others that the entire 2nd millennium BCE (Middle Bronze II & III, Late Bronze and Iron Age I) is absent in this region. However, radiocarbon dating and geoarchaeological approaches were not used in these investigations. Excavations at Horvat Haluqim were continued by Bruins, first in agricultural terraces and later in building structures. Though ceramic remains are scarce, it is clear that Negbite pottery sherds dominate at the site. Rothenberg found Negbite pottery at Timna, also defined by him as "Rough Hand-made Pottery" together with datable Egyptian artifacts in the range of the 14th to 12th century BCE (Late Bronze Age and Iron Age I). Therefore, he suggested already in 1972 that the sites in the central Negev Highlands, usually attributed to Iron Age II, might have an older beginning and include the Late Bronze Age and Iron Age I. Indeed, these time ranges have now been found for the first time in the Central Negev Highlands at Horvat Haluqim, where extensive radiocarbon dating has been used, as well as detailed geoarchaeological and micro-archaeological approaches. Living floors were uncovered at the edge of terraced agricultural field no. 12 (Area 5) in the eastern wadi near building remains. A bronze chisel was found in these layers. The geochemistry of the chisel shows a composition of tin bronze, containing 89.7% copper, 2.5% tin and 1% lead. The lead isotope ratios of the bronze chisel determine that it was made from either Feinan DLS or Timna copper ores. Radiocarbon dates of layers near the bronze chisel give a 2σ age range of about 1190-1010 BCE, i.e. Iron Age I. The sequence of living floors and their extension in the terraced field in Area 5 yielded so far 21 radiocarbon dates, which give an accumulative age range (2σ) of occupation from about 1493 to 916 cal BCE, i.e. Late Bronze to Iron Age II.

A Comparative Study Of Cypriot Bronzes Dating To The Late Bronze And The Early Iron

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The present comparative analytical study concerns the interdisciplinary investigation of more than 250 archaeological bronze artefacts and objects, coming from two Late Bronze Age sites, Pyla-Kokkinokremos (Karageorghis and Demas, 1984) and Limassol-Enaerios (Karageorghis and Violaris, 2012), and an Early Iron Age site, the necropolis of Palaepaphos-*Skales* (Karageorghis, 1983).

These include several types of bronze tools such as knives, saws, and needles, weapons, such as daggers and spearheads, utensils and vessels, such as, *obeloi* (roasting spits), tripod stands, and hemispherical bowls, and ornaments such as pins, fibulae, and ear-rings. Also, among the studied material are various pieces of scrap bronzes (Pyla-Kokkinokremos) and a small group of amorphous lumps of metal (Limassol-Enaerios). The material is published and there have been some specialized studies on the tripod stands and the metal vessels (e.g. Papasavvas 2001 and 2004, Matthäus 1985). However, this important assemblage of Late Bronze and Early Iron Age Cypriot metalwork has never been analysed as a whole and thus very little is known about the alloys used to produce these artefacts.

For the specific study, a portable handheld XRF was used for the determination of the chemical composition of the bronze artefacts and the metal lumps. The analyses were performed on clean, free of corrosion layers, surface areas of the objects. Furthermore, a small number of

artefacts were chosen for the removal of a small surface area (5x5 mm) of the corrosion layers, and analyses were also performed on those areas, exhibiting very small compositional differences, when comparing with the selected clean surface areas of the artefacts.

The aim of this research project is the chemical analysis of the objects in order to ascertain the types of alloys used and whether there is a differentiation in composition depending on the type of object. Furthermore, as this is part of a diachronic study of Cypriot metalwork undertaken by the authors, possible changes in the composition of copper alloys used in different periods on the island will also be investigated.

Iron Age Copper Production: A Study Utilizing Mining And Smelting Activities At Timna And The Fenan Valley

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The geographic location of the Timna mining operations and the Fenan facilities in the Arabah Rift Valley encouraged a unique concentration of copper production during the early Iron Period. The stratification of industry in southern Palestine began of diverse origins, with as many as four differing ethnic groups working alongside one another in the mines of Timna and the Fenan sites. As the economy of the region fluctuated, metal production entered a new period of localized control, where technological advancements would be fostered by locally controlled entities. Research from recent C-14 samples of Site 30 of Timna, and of Khirbat an-Nahas suggest that while it is likely that the time of operation of these sites coincided only briefly, the presence of local inhabitants who were involved in copper mining and smelting is certain. While they were simultaneously mining in a relatively regional area, Fenan and Timna adopted different methods of mining and smelting, raising the question, who were these people? Were the populations at Timna and in the Fenan of the same ethnic group, working at sister copper-producing sites, or, could this be an example of localized competition? Using a comparative study of mining techniques, this research focuses on utilizing data recorded at Timna during the excavations of Beno Rothenberg in conjunction with reports of excavations at the Fenan site of Khirbat an-Nahas to propose that it was the strong competition between Timna and Khirbat an-Nahas during the twelfth century B.C.E. that enabled metal production to maintain general stability, despite the incongruences in the economic and political situation of the Iron Age Near East. As future excavations on smelting and mining areas are conducted in the Arabah Rift Valley, the interactions between workers at Timna and Khirbat an-Nahas will hopefully provide more details into why the Khirbat mines outlived those of Timna, and provide researchers a greater understanding of the relationship between early Iron Age mining and metalworking people.

Recent Discoveries From The Timna Valley Survey

Eli Cohen Sasson

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Timna Valley has been evoking scholarly interest since the second half of the 19th century; however, systematic archaeological research in the region only began with the establishment of the „Arava Expedition“, under the direction of Beno Rothenberg, in 1959. The meticulous work conducted by Rotenberg revealed the complete cycle of copper production in the valley, and outlined, in detail, the specific techniques that were employed during the various archaeological periods. Moreover, this project led to the discovery of important features such as mining shafts and galleries, work camps - with numerous furnaces, massive slag heaps, dwellings, sanctuaries, rock-art monuments, and burial places. The pioneering research of the “Aravah Expedition” became an important corner stone in the construction of the growing discipline of archaeometallurgy as well as an integral part of the archaeology of the arid zones of the southern Levant. The “Aravah Expedition” systematically opened up the Timna valley for scientific research, defined and elaborated new research methodologies, and made innumerable scientific breakthroughs.

In light of the astonishing discoveries made by the “Aravah Expedition” a new study of the Timna valley late New Kingdom mining community has been carried out since

2007 by Ben-Gurion University of the Negev under the direction of Dr. Yuval Yekutieli. The project implements thorough and non-intrusive archaeological methods to examine various aspects of social relationships within the mining community that operated in the Timna valley during the end of the second millennium BCE. Previously unknown aspects of the ancient social landscape of the valley were discovered through the application of Landscape Archaeology, Geographic Information Systems, aerial photography analysis, digitized surveying, and intensive fieldwork. This lecture will showcase some of the recently discovered sites and artifacts from the new archaeological survey of the Timna Valley.

The Role Of Copper To Tools In Early Egpytian Society:

THE CASE STUDY OF TELL EL FARKHA COPPER OBJECTS ASSEMBLAGE

Marcin Czarnowicz

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In the pre- and early- dynastic period copper was a metal of the great value. Its presence in occupations layers and gravers is exceptional. Archaeologists belief that objects made of this metal underlines a wealth and high rank of its owner in the society. From the other hand, during the time of the Naqadan expansion and state formation, this was one of most important trade goods imported to Egypt from Southern Levant.

Tell el-Farkha was a large and important political center being a bridge linking the Upper Egypt with the Near East. During the pre and Early Dynastic period a large quantities of imported commodities were moved through the site with caravans going to or returning from the Southern Levant. Long distance trade was one of the most important branches of the local economy.

Up to now at the Tell el-Farkha over 40 copper object were found, making one of the biggest and most complex assemblages dated to pre and Early Dynastic Period giving us a good opportunity to study not only its metallurgical aspect but also its impact to local society and economy. Copper objects found at Tell el-Farkha seems to shed a new light on the problem.

During my presentation I would like to focus on the socio-economical aspect of the copper tools presence at the site. In our assemblage we have excrete artifacts such as social status markers as long as tools used in local workshop's building up local economy. There is also a group of objects observed in storerooms of the administrative – cultic center which might be used in trade together with other imported items. Artifacts will be presented together with its analogies from other sites and its context and its role in understanding of socio economical processes at observed at the site will be discussed.

King Herod and the Copper Mines of Cyprus

Shimon Dar

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From where did Herod the Great obtain the large sums of money he needed for the building programs in Judaea and other countries around the Mediterranean?

King Herod kept a large court of officials, an army and a navy, which cost large sums of money. According to Josephus Flavius, the income from taxes in Judaea reached the sum of 1,050 talents, a great deal of money, but hardly enough to cover the Herodian expenses.

Two examples demonstrate the large sums of money the king needed for his building programs: The estimated cost of building the Caesarea harbor was 1,750 talents, and the construction of the temple mount cost 1,200 talents. It seems that the direct taxes King Herod collected in Judaea, were a fraction of the real budget of the Kingdom: Herod engaged in commercial activity with the Nabateans and received royalties from the lucrative spice trade, and received from Augustus the tax collection in Syria and part of Asia Minor, but the main source of money was in the right to exploit the rich copper mines of Cyprus.

According to Josephus (Ant. 16.128), Augustus, King Herod's patron, gave Herod half of the income from the mines, and nominated him as overseer for the second half of the mines. Copper and by-products were a lucrative commodity in antiquity, and the mines in Cyprus were known for their richness.

We may assume that the Jewish communities in Cyprus were involved in the economy of the copper mines. Marriage relations existed between the Herodian dynasty and a Jewish aristocratic family. The Jewish communities in Cyprus were well established all over the island, especially in the Hellenistic and Early Roman Period. Those communities suffered severely after „The Diaspora Revolt" in Trajan's days.

Early Bronze Age Refining Of Copper

Christopher Davey

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The Third Dynasty in Egypt saw the beginning of monumental stone masonry and the development of a large-scale copper industry in the Nile valley. This industry was depicted on some Old Kingdom tomb-walls showing the use of a distinctive style of crucible, the profile of which became the hieroglyphic ideogram for 'metal-worker'. Such crucibles have been found at Tell edh-Dhibai'. However in an upright position, these crucibles will not retain a liquid, begging the question of why were they used for melting copper? This paper argues that the crucibles were in fact originally used for refining copper at remote arid smelting sites, and were taken to Egypt by metal workers to carry out refining in association with the production sheet copper for the fabrication of prestige copper artefacts. The reasons why these crucibles have not generally been identified at smelting sites will be discussed. It will be argued that the crucible design and practice was partly determined by the environment, that they were used repeatedly until they disintegrated and that their remains would have been ground up as grog for new crucibles. It will also be argued that the complexity of the crucible shape does not assist archaeologists when reconstructing vessels from fragments.

The Late Chalcolithic Copper Hoard From Nahal Mishmar (Judean Desert, Israel) In a Regional Perspective

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In 1961, a Chalcolithic (c. 4500-3800 BC) hoard of over 400 copper artifacts was found in a remote cave in Nahal Mishmar (Judean Desert, Israel). Until today, The Cave of the Treasure hoard is the richest and most sophisticated assemblage of proto-historic metal objects uncovered in the ancient Near East. Over the past decades the hoard was the focus of several investigations, pertaining mainly to its metallurgic technology, artistic milieu, and socio-cultural attribution. Of the many interpretations regarding the cultural background of the hoard and the circumstances which led to its deposition, the two most influential ones view the hoard as either the stored goods of semi-nomadic pastoralists specializing in metallurgy, or as an ephemeral or permanent cache of cultic objects originating in the nearby shrine of En-Gedi, which is associated with the sedentary Ghassulian culture. However, these and other suggestions were not based on a holistic investigation of the regional picture emerging from the Judean Desert during the Chalcolithic period.

Recently, the spatial, environmental and material aspects of 70 caves in the region, as well as few other sites, were analyzed and re-evaluated. The results demonstrate that the Cave of the Treasure was part of a wide-scale phenomenon of occupation of hardly-accessible karstic caves in the cliffs of the Judean Desert, which cannot be explained as transient shelters for pastoral nomads. In addition, the cultural assemblages collected in these caves differ fundamentally from those collected in the En Gedi shrine, suggesting either cultural or chorological disconnection. Based on the entire bulk of data, gathered in the present study as well as in other recent studies, it is suggested that the hoard from Nahal Mishmar was 1) manufactured within a specialized sedentary context of as yet unknown location; 2) used as paraphernalia of a cultic structure, or in another cultic context, but not the En Gedi shrine; and 3) deposited in the cave as part of a temporary

refuge of the population who owned the hoard, which fled to the Judean Desert caves at times of distress.

Looking Beyond The Levant: Configurations Of Copper Production In The Late Bronze Age And Early Iron Age Southern Caucasus

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Research on copper production at the end of the Bronze Age and beginning of the Iron Age has tremendous potential for illuminating the social and economic organization of societies during this crucial period. Moreover, theories for the rise of iron rely on a clear understanding of the relative organization of copper and iron production.

In collaboration with colleagues at the University of Oxford, the University of Exeter, and Shota Rustaveli State University in Batumi, I have undertaken a combination of survey and limited excavation on a landscape of metal smelting sites along the Black Sea coast of the Republic of Georgia. Previous investigations by Georgian scholars have identified as many as 400 smelting furnaces, scattered across the foothills of the region.

A combination of GPS mapping of sites and archaeometric analyses of smelting debris offers insight into the technology and organization of production. Analysis of the slags, combined with geological information about the region, suggest that copper was extracted from sulfide ores using a multi-stage reduction procedure. Despite the high degree of expertise required for mining and smelting these ores, as well as the massive scale of the industry in aggregate, individual smelting sites are small, suggesting a dispersed mode of production. This mode of organization differs from the Levant, where the same period is marked by several large concentrated smelting workshops. Additionally, it contrasts with traditional models of Late Bronze Age production and trade, which views copper production activities as highly organized elite-controlled operations, while iron was a more widely available metal.

Analysis of slags from these sites also provides tentative information about the emergence of iron production. The iron-rich slags are suggestive of highly reducing conditions, to the extent that metallic iron and wüstite are occasionally found. Further work will assess the consistency, frequency, and dating of these indicators, as a way to determine whether metallic iron was a recognized, and perhaps even desired, byproduct of copper smelting. If so, this would provide direct evidence that iron smelting emerged from, and coexisted with, traditions of copper smelting in this region.

Toxic Metals In Humans In The Faynan Area

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We measured the concentrations of toxic metals (lead (Pb), silver (Ag), and copper (Cu)), and non-toxic metals (calcium (Ca), barium (Ba), and strontium (Sr)) and the isotopic composition of strontium (Sr) and Pb in Iron Age (ca. 11th - 10th c. BCE) buried humans, soil samples, and production slags near Faynan, Jordan – one of the major metallurgical centers in the Old World. Our results show that most of the people buried in Faynan were not involved in metal production and were not contaminated; however, there is a small group of people who were exposed to metal pollution since their childhood.

Decorated And Plain Ceramic Wares And Beads From Reent Excavation In Timna, Site 2

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Four seasons of excavations on the northern edge of Timna, Site 2, conducted on behalf of the Israel Antiquities Authority and the Timna Park have uncovered an array of ceramic vessels, including decorated wares, and an abundance of beads of many different types.

The decorated ceramic vessels are assumed to have been produced at the North Arabian site of Qurayya, south-east of Timna, while the plain wares, mainly in the form of storage jars are of Cannanite and Egyptian origin.

A profusion of beads of a variety of types have been uncovered throughout all the excavated areas including areas used smelting.

Many of these artifacts will be presented and discussed in their archaeological and historical context including the apparent tradition of decorated ceramic wares produced in desert oases in the region from the Late Bronze Age period and into classical times.

The Mysterious Copper Scroll

Robert Feather

Independet scholar

In 1952 a French archaeologist, Henri de Contenson discovered two pieces of heavily corroded copper hidden in a cave near Qumran, on the northwest shore of the Dead Sea. The original copper scroll measured 2.4 x 0.8m and was engraved with Hebrew text and Egyptian terms dating to at least 2,000 years ago. The copper was 99.9% pure with traces of arsenic and iron, and subsequent to the cutting open of the scroll there has been endless speculation about the meaning of its contents and the source of the copper from which it was produced.

This paper describes the fabrication techniques and composition of the copper and suggests possible sources for the origins of the copper material.

Volume And Mass Estimation Of Mine Dumps And Slag Heaps Using High-Resolution Terretrial Laser Scans

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Characterization of complex environments in a detailed and accurate manner challenges common documentation practices. Estimation of derived information such as volume and mass in a reliable manner offers even a greater challenge. Nonetheless, such estimation is of value when attempting to reconstruct past mining activities using dumps or slag heaps, which do not bear simple shapes and may be embedded within complex topographies.

In this research we employ terrestrial laser scanning to depict and characterize features of that kind and to estimate their volume and derived mass. Terrestrial laser scanning is one of the rapidly emerging technologies to generate a true-to-reality 3D documentation of scenes. Offering dense and accurate 3D data, which are acquired directly, they facilitate a detailed surface and objects description irrespective of their shape complexity. We demonstrate the principles of the technology and related processes which are leading to the depiction of the complete scene, its characterization, and finally the estimation of volumes and mass.

We apply the proposed method on mine dumps in Nahal Amram and slag heaps Be'er Ora. At Nahal Amram, large scale copper mining took place during the Nabatean to Early Islamic periods, leaving quantities of dumps below the mines. By 3D scanning of the area, which was covered by dumps and later on partially eroded, and processing the data, we estimate the dumps volume and mass. At Be'er Ora, large piles of copper slag remained in a smelting camp dated to the same periods. We employ similar methodology to compute slag volume and mass, allowing estimation of the amount of copper produced therein.

Production Of Copper At Differen Scales In The Early Bronze Age Aegean

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Recent research in the archaeometallurgy of the Early Bronze Age (EBA: 3rd millennium BC) Aegean has brought forward significant new evidence for the production of copper. Such practices can now be identified in at least two different models: small-scale production in the vicinity of some settlements and large-scale production at a distance from settlements and in regions broadly enriched with ores. The present paper presents a synthesis of Early Bronze Age Aegean copper production with emphasis on 'isolated' versus 'attached' production sites.

The paper explores issues such as the uniformity of production, the scale, and the availability and need for transportation of raw materials, through a presentation of recent field and analytical evidence. In the case of the 'isolated' production the question of who was involved in these activities needs to be addressed. To this the fragmented small island environment of the southern Aegean and the relative scarcity of copper ores in this area form a uniquely challenging background. On the other hand how widespread were 'attached' production sites? What types of settlements are these encountered in and how homogeneous are metallurgical practices with relevance to available resources? Difficulties in dating these sites precisely are acknowledged. Did these different models of production co-occur in the EBA? Do they represent a contemporary 'different way of doing things' or a chronological development throughout the EBA?

On a broader level, using the EBA Aegean case study the paper wishes to open a discussion that challenges our frequent preconceptions in classifying distinct production models in different periods, often assuming an evolutionary trajectory.

Experimental Reconstruction Of Bronze Age Chalcopyrite Smelting By Employing Traditional Techniques From Nepal

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Since 2010 archaeo-metallurgical experiments are conducted within the FZ HiMAT research program with the aim to reconstruct Bronze Age smelting techniques by employing traditional methods from the Himalaya region, Nepal. Starting point are well documented archaeological records of Middle to Late Bronze Age copper ore smelting sites in the Eastern and Southern Alps, mineralogical analysis of smelting products and ethno-archaeological records of contemporary copper ore smelting in Nepal. The applied method combines the up-to-date knowledge of the involved disciplines in order to approach as close as possible the reconstruction and reproduction of Bronze Age smelting technologies.

In July 2012 experiments were performed during a two weeks outdoor workshop in Jochberg, North Tyrol. The camp locality has been chosen because of its original situation in the midst of a well known Bronze Age copper ore mining and smelting district. In preparation of the smelting experiments a certain amount of local copper ores from ancient mining dumps were collected.

The smelting ?hearth? (rather than ?furnace?) was set with local stones in a rectangular form and completely covered interiorly with clay. Several portions of the ore concentrate (10 kg in total) were smelted in the hearth with charcoal, using two leather bellows, each one attached to a bended tuyère. The aim of the first smelting was to produce a certain amount of matte. The matte concentrate was grinded into powder with stone tools and mixed with horse dung. The balls were roasted for about two hours in an open wood fire in a ?roasting bed? and then left over night until the ongoing reaction was

completely terminated and the material showed a dark red color as a sign of successful roasting. The roasted matte was then smelted in the hearth with charcoal under the tuyères. The products were analysed in the laboratory using microscopy and electron microprobe analysis.

This paper also raises the issue of how several methodological approaches may be used in order to explain copper smelting technology and its social impact.

The Location Of Specialized Copper Production During The Chalcolithic Period As Evident From The Study Of Production-Related Ceramic

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The origins of southern Levantine Chalcolithic copper metallurgy has been debated for decades. Typological and metallurgical examinations of the copper artifacts from the Nahal Mishmar hoard and elsewhere have indicated a dichotomy between simple tools, made of pure copper by open casting, and elaborate items made by the „lost wax" technique of copper alloys with antimony and arsenic. While the first were considered local production of the northern Negev sites, the prestige objects were either considered as imports from the remote sources of arsenic copper, or local to the southern Levant. In the present paper the results of an ongoing research project will be presented, based on the analysis of ceramic mold remains that were still attached to a large number of copper implements from Israel. In a previous publication, the En Gedi area in the Judean Desert of Israel was suggested as the place of origin of all copper objects produced by this method. Some new results and simulations of the technique shed more light on the production process and suggest better explanations to the problematic archaeological evidence.

Copper and Environment in Timna as a platform for Earth Sciences, Archeology Study and Tourist Programs

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Timna Valley is „The place" to see, to feel, and to understand the common story (and history) of man and copper.

The Timna Valley is located on the western boundaries of the southern Arava. The valley has a fascinating geological history, which formed the landscape we see today. All the main rock units of the region are exposed in the valley and the cliffs beside it. The landscape forms sculptures of pillars, arches and canyons, which are very attractive for students. These formations are exposed because of the lack of natural plants (except the active streams) in this extreme arid zone. Copper appears in three different rocks in Timna – granite, dolostone and sandstone. The copper ores found in the valley attracted man as far back as the fifth century BCE . Over the generations, man mined the copper ore from the rock and turned it into metal. The methods, the tools and the technologies used in the production of the copper developed and advanced over the generations as evidenced by the many remnants and discoveries left at various sites in the valley.

Through a long and arduous process, man learned where to find minerals that contained copper and how to mine them. He learned how to refine the copper and how to create tools and other useful items.

The vast amount of remains and evidence found in the Timna Valley is an indication of this process from the beginning through its many stages. These remnants are the documentation of the history shared by man and copper – trial and error and success.

The social, economic, cultural and spiritual world experienced by generations of miners is revealed in the remains of ancient dwellings and work sites. Here we find religious artifacts, carvings and rock drawings, burial sites, and other archeological findings.

Just by virtue of the magnificent natural scenery, Timna Park can stand side by side with some of the most famous national parks in the world, but its uniqueness is the combined history and geology values. The combination of an arresting landscape and rich history creates an excellent platform for studying geology and archeology. The following is a list of recent study topics.

1. 6,000 years of man and copper in Timna Valley – A multidisciplinary high school program for grade nine that includes lessons in class, field trips and final projects.

2. Independent research projects and Geotopes as part of 11th and 12th grade science study. Topics including "creation of copper ore" in Timna or "pace of degradation of streams beside the ancient shafts" become the most meaningful and enjoyable learning in school.

3. Field trips in Timna, with written booklets, as part of the curriculum of earth science study, leading to active learning of the geological rock – landscape units of south Israel.

4. Field navigation with aerial photos through the old mines beside the arches with a task to discover the type of mining and the tools that were used for mining.

5. Mini-posters that help to explain the geological history of Timna Valley and the story of the copper. These are used for guiding school students and other visitors.

All these tools were developed through Ma'aleh Shacharut High School and The Dead Sea and Arava Science Center and were very useful for studying and understanding the stories of Timna Valley.

Our main challenge is to find the way to make the unique values of Timna accessible as the park's main tourist attraction. Adopting the concept of ‚educational tourism' enables us to help the visitors experience and understand / absorb those values. Relating to Timna as an active field laboratory and hosting research expeditions at the park holds great potential as a means to respond to that challenge.

Evidence Of Floods In The Amram Copper Mines

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The Amram Valley was an important center for copper mining throughout history. Extensive underground copper mines in the soft Kurnuv sandstone appear as long galleries, halls and shafts in different surfaces. Most of the splits are ten meters above the recent streams (wadies). Mining was active mostly through the Nabataean (Roman) and Early Islamic periods.

Over 40,000 tons of overburden, mostly white sandstone, were removed from these mines. Half of it is still exposed in Amram Valley beside the ancient mines, and half was carried away by the Amram Stream toward the Arava Valley.

In several fluvial terraces are observed inside several mines are exposed in the mines. Some of the terraces are more than one meter high and contain mostly sandstone pebbles and, in few sites, limestone angular pebbles. Most of the terraces contain also fine quartz grains and some clay, and thin layers can be recognized. In these sites some of the fluvial terraces are cut off and the outcrop is exposed. Some of the shafts were also filled with the fluvial components. An acacia plant remain found in fluvial sediments in one shaft was dated by ^{14}C to 240 A.D.

These sediments are evidence for floods that occurred after the opening of the mines. Signs beside the sandstone walls are fluvial and suggest that some of the galleries were filled with these sediments. Elongated signs of digging picks were discovered in the fluvial sediments, suggesting that workers needed to remove the sediments during mining. Probably part of these sediments were excavated by the workers and part were carried by strong floods and deposited in the lower part of the cave.

An extreme rain event occurred in the Amram region on 18.11.2012. More than 30 mm' of rain fell in less than an hour and a strong intensity flood developed in the streams. Degradation of more than 50 cm. in the fluvial deposits was measured in some sites, suggesting a flood

that developed on a limited slope area and brought water and sediments to the cave, causing this incision. This event suggests similar ones in the past, some on a larger scale. Detailed study of these fluvial sediments can be a key for the knowledge and understanding of intensity and time of floods during the mining periods, between and after them.

Archaeometallurgical Research In The Nrothern Hajjar Mountains (Oman Peninsula) During The Iron Age (1200-300 Bce)

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Recent archaeological investigations by the French archaeological mission directed by Anne Benoist in the Emirate of Fujairah (U.A.E.), revealed intensive extraction of copper ores and extensive use of copper and copper alloys during the Iron Age. Collected data allow us to investigate all the chaîne opératoire, from the ore to the final object.

The successful metallurgy production stemmed in the geological background of the Oman peninsula and the ophiolitic al-Hajjar mountains. However, little is known about the economical and social contexts in which this copper metallurgy was carried out.

The results of three surveys campaigns are summarized here, together with the first results from excavations at a smelting site and a mining site, as well as those from chemical analysis carried out on ingots, slags and objects from Iron Age sites of the Oman Peninsula.

key words : Iron Age, mining, metallurgy, copper, chemical analysis, survey.

Judah Of Iron Vs. Israel Of Copper – The Paradoxes Of Metalworking Development In The Land Of Israel

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Jane Waldbaum demonstrated that the introduction of iron into the Levant began in the 12th century BCE, with the sporadic occurrence of iron objects represented by a very limited repertoire of types; the process continued with a gradual employment of iron for all categories of objects and finally the replacement of bronze as leading metal for practical purposes in the 10th century BCE.

The renewed study of the evidence for metal-working (copper/bronze and iron) in the Iron I and IIA in the Land of Israel enabled the reconsideration of the circumstances of the process of transition from bronze to iron in the Land of Israel. It revealed that this process was not homogenous throughout the country; the adoption of iron metallurgy occurred gradually and inconsistently.

The comparative analysis of material from northern valley sites and the Beersheba Valley reveals a discrepancy in the progress of technological development: by the early Iron IIA, the iron industry in the south was already relatively well developed, while in the north it remained largely ignored and smith continued to work in bronze.

It appears that the newly-founded poor villages of the Negev, and not the culturally-developed centres of the north, were the first to adopt the new ironworking technology establishing an infrastructure for the principal metal industry of the Kingdom of Judah. On the contrary, in the centres of the north, iron was not appreciated for its utilitarian potential for a longer period; copper-working remained there the principal metal industry well into the Iron IIB.

A striking case is also the disparity in the metalwork evidence between the contemporaneous early Iron IIA Beersheba Valley sites of Tel Masos II on the one hand and Arad XII and Beersheba VII on the other. All three sites belonged to the same settlement entity and were located in equal proximity to the Feinan copper production centre. But while Tel Masos II shows extensive evidence of copper-working, which fits its involvement in the Arava copper trade, Arad XII and BeershebaVII feature marks of an iron-dominated metal industry.

Copper Trade and the Rise of the Settlement in the South Levant Deserts in the Early Bronze Age IV

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About 1500 sites of the EBIV have been surveyed in the Negev and Sinai deserts. The sites can be divided to two groups:

Group one: About seven sites, such as Har Yeroham, Beer Resisim and Ein Ziq, are large sites, consisting up to 200 structures, located near water sources and can be defined as permanent settlements. Excavations conducted in most of the sites sowed that copper process and trade constitutes the main economic activity identified. This identification is based on the abundance of copper ingots and an unusual amount of stone tools, probably used for copper processing: hammerstones, grindingstones and work tables, 20-40 stone implement in a single room. No evidence of subsistence activity, such as sickle blades or animal pens has been found.

Group two: All other sites are small, poorly built and located far away from water sources. This drives to the conclusion that they are temporary. The enormous number of animal pens found in the sites attest that pastoralism was the dominant economic activity. Sickle blades found in several sites sows that seasonal agriculture was also engaged. In addition, rich findings of cairns, stone piles and stone lines, evidence of traditional desert population burials and cult features has also been found.

The rise of settlement in the south Levant deserts is a result of circumstances enabled Asians to transport copper to Egypt and. The permanent settlements reflect copper-specialized groups transporting standard ingots from the Feinan copper mines to Egypt. Following the establishment of those sites there was a rise in semi-nomadic activity throughout the area south to the permanent sites.

The settlement pattern reflects a complex system consist of copper specialists and semi nomads, however the head of the system is still enigmatic.

Based on the examination of several cultural characteristics both in permanent and temporary sites, the possibility to locate the system‘s head in one of the Arabian Desert oasis‘s should not be excluded.

The Differentiation Of Ancient Copper From Timna And Faynan Throuhg Stable Cu Isotopes

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The copper ore deposits of Timna and Faynan, Wadi Arabah, are of the same geological genesis. Therefore, provenance studies for archaeological copper objects from the two districts by trace elements and/or lead isotopes are difficult and limited (Hauptmann 2007).

Copper has two stable isotopes: ^{63}Cu and ^{65}Cu. Generally, the determination of the copper isotopic composition ($\delta^{65}Cu$) of archaeological copper and bronze artefacts allows the discrimination of the use of primary and secondary sulphidic or oxidized ores because of a significant natural variability (Klein et al. 2010). In the case of Timna and Faynan oxidized and supergene sulphidic ores occur.

Ores of different geologic units as well as crescent shaped bar ingots from the Early Bronze Age III/IV metal workshop of Khirbet Hamra Ifdan (Levy et al. 2002) in the Faynan mining district were analyzed in this study for their copper isotopic ratio. The ores and the ingots show a consistent homogeneous isotopic composition and confirm the local provenance of these ingots. Like in previous studies (Gale et al. 1999) a fractionation of copper isotopes through metallurgical operations could not be detected. Ores of the Amir Formation in Timna, which were exploited intensively in ancient time, show a significant lighter composition and a larger range in their copper isotopes (data presented by Asael 2010). Because of this difference the ratio of stable copper isotopes might be useful as distinguishing criteria for ancient copper from the two districts.

The 'Araba Copper Industry In The Islamic Period: The View From Faynan

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Faynan and Timna, located at roughly opposite ends of the Wadi 'Araba, contain the two primary copper ore bodies of the southern Levant. Though exploited throughout antiquity, copper production continued in both locations during the Islamic period, with both showing distinctive patterns of exploitation. Excavation of Islamic period copper production sites in Timna began with the work of the late Dr. Beno Rothenberg and the Arabah Expedition, but similar research in Faynan has been limited primarily to survey. With this in mind, the Edom Lowlands Regional Archaeology Project (ELRAP) recently expanded its research program to investigate this period, the last phase of copper production in the region. This paper reviews the archaeological evidence from Timna and summarizes Islamic period material excavated by ELRAP teams at the Middle Islamic copper producing village of Khirbat Nuqayb al-Asaymir, the multi-period tell of Khirbat Faynan, and the later caravanserai at the primarily Early Bronze Age settlement of Khirbat Hamra Ifdan, and situates the changing patterns of Islamic period copper production in the Wadi 'Araba within shifts in the geographic and productive foci of the economy of the southern Levant.

Cypriot Copper Production And Trade In The 13Th Century Bce – A Technological And Economic Success Story From The Late Bronze Age

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Cyprus emerges as an important copper production centre sometime in the beginning of the second millennium BC. This is supported by both the archaeological finds from the island and the texts of its Near Eastern neighbours where Alashiya, now widely accepted to represent Cyprus, first appears as a source of copper. It is, however, in the second half of the second millennium, namely in the Late Bronze Age that copper production really takes off and Cyprus begins to produce enough metal to satisfy not only the local needs but also the demands of the complex societies around her. This significant development is a result of major technological advances in smelting technology. By the 13th century copper production becomes the basis of the Cypriot economy as clearly shown by the plethora of evidence coming from excavated sites throughout the island. This is the period that a miners' village was founded at the mine of Apliki and that the copper workshops at the most important urban centre, namely Enkomi, expanded significantly. Not surprisingly it is also the time during which Cypriot copper, in the form of oxhide ingots flooded, the Eastern Mediterranean market. The scope of this lecture is to present the current state of archaeometallurgical studies on copper production on the island in the 13th century BCE, a time during which copper production in Timna also intensified.

The Amram Valley, Israel: A Survey Of Underground Copper Mines

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The Amram valley is a small erosive crater on the western side of the southern Arava, 12 kilometers north of Eilat and 10 kilometers south of the Timna valley. The valley is delineated by limestone cliffs (Evrona cliffs) with an altitude of 570 meters above sea level. At the bottom of the valley, a few hundred meters below the top of the cliffs a wide range of sandstones and magmatic rocks crop out. The valley has a number of wadies, the largest of these are Nahal Amram and Nahal Zfonot, that descend to the south and north of Mt. Amram.

It is not difficult to notice that this valley has extensive areas with many cave openings. These man made voids, used for copper excavation purposes, were surveyed in the past mainly by Prof. Bano Rotenberg and Lin Willis, who documented many openings. A renewed examination of these copper mines is currently being conducted, led by Dr. Uzi Avner with additional researchers. Since the beginning of the renewed research, the Caves Research Center has been conducting a comprehensive survey of the different openings. The documentation of the openings is being carried out with several methods but initially by mapping. Mapping a cave is the basic action carried out by anyone who wishes to collect data, to document or study the underground area. The cave map provides information on: the size of the cave, its depth and direction, the structure and complexity of the cave. In recent years there have been extensive technological and methodological changes in cave research, so that the re-examination and mapping of the copper mines provides new information about these mines. An example of this is the largest mine mapped so far. The current survey showed that the full length of the cave mine reaches 1,160 meters. Inside the mine, a ‚new' wing was discovered with impressive archeological findings- an improvised kitchen with the remains of equipment left by the miners. All together, 39 mines were mapped, varying n length from three to 1,160 m. Analysis and comparison of the maps provide additional insight regarding the planning of the mines and their form, the boundaries of the excavation areas, changes in the structure of the mines in different periods, the stability of the spaces, the archeological inventory by areas and different spaces, etc.

The documentation of the copper mines in the Amram valley demonstrates the intensity of the mining in this area. It seems that many additional findings are yet to come.

The Rabbis' Knowledge Of Copper Alloying Is Implict In Laws Of Purity And Impurity

Dan Levene

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Copper based alloys are uniquely varied in terms of compositional and artefactual variety. The types of objects produced from these alloys range from nails to rings, tools to military panoply, bowls, household figurines and monumental statuary. Bronze (copper + tin), brass (copper + zinc), gunmetal (copper + tin + zinc) and to a lesser extent Corinthian bronze (copper + gold + silver) are the better known alloys. These are, however, but crude characterizations of a much wider variety of alloys created when control of the proportions of their constituents is exercised to produce differences in colour, hardness, ductility and other properties. This versatility is both reflective and indicative of technological developments and aesthetic preferences that were governed as much by tradition and culture as by practical considerations. Our knowledge and understanding of the diversity in the selection and control, as well as use and recycling of copper alloys amongst the peoples of the Near East is scant, but what we have suggests considerable variation, linked to ethnicity and cultural orientation. The available evidence suggests that there was a difference between the copper-alloy technologies of the Roman Empire and that of Persia. For example, it is suspected that in the LA Persian sphere, unlike its Roman counterpart, brass was neither produced nor used. A textual indication of this might be found in the LA Jewish Tosefta (Kelim BM 1:3) which states that the Jews distinguished scrap metal from Palestine from that which came from abroad. We

propose that such differences in the use and production of alloys can be investigated by the chemical analysis of an appropriately selected sample of objects, and that the differences in production processes and object types distinguishing Roman and Persian spheres can likewise be detected in the Hebrew and Aramaic literatures of the time that were produced by sister communities across this divide. In a region where metal ores are scarce, it is likely that recycling was the prime source of metal. Researchers have largely ignored this option because it is essentially invisible to archaeology. However, the collaborative research I have done with Matthew Ponting reveals recycling of metals to have been a major industry. This paper builds on the work I did with Beno Rothenberg in the last two decades of his life and is a tribute to him.

Intensive Surveys, Large-Scale Excavation Strategies And Ancient Metallurgy In Faynan, Jordan

Thomas E. Levy

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Beno Rothenberg pioneered regional studies of ancient metallurgy through his research and publications in the Timna valley (Israel), Rio Tinto (Spain) and other regions in the Old World. From 1983 to 1993, Andreas Hauptmann and researchers from the Deutsches Bergbau-Museum (DBM) were influenced by Rothenberg to carry out a similar pioneer regional study in the copper ore rich Faynan region in Jordan's northern Wadi Arabah. The DBM project focused on the history of copper technology from the beginning of ore exploitation in the Pre-Pottery Neolithic (PPNB) to Islamic times by small-scale sampling of sites specifically related to metallurgy. In 1997, the University of California, San Diego and the Department of Antiquities of Jordan embarked on an anthropological archaeology project that looked at the same 'deep time' trajectory in Faynan but with a different focus. The new project, which continues today in collaboration with Mohammad Najjar, aims at understanding the social, cultural and historical dimensions of ancient metallurgy in Faynan. By using cyber-archaeology methods of data recording, in-depth 100% pedestrian surveys to record all archaeological remains coupled with large-scale horizontal excavations at the main Faynan production sites, new insights on the role of metallurgy in south Levantine culture change in southern Jordan has been achieved. This paper presents some of the conclusions reached for the main periods of mining and metallurgy in Faynan – the PPNB, Early Bronze Age, Iron Age and Islamic period.

Iron IIA Pottery from the Negev Highlands: Petrographic Investigation and Historical Implications

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The paper reports the results of a petrographic investigation of pottery from Early Iron IIA settlements in the Negev Highlands. The origin of a substantial portion of the vessels can be pinpointed to the copper districts in the Wadi Arabah. Among them slag-tempered wares bear mentioning in particular. It has been suggested that the copper extraction system in the Wadi Arabah was operated by tribal, desert groups. The petrographic data adds another dimension, demonstrating that the subsistence economy of the Negev Highlands sites was supplemented by activity of at least part of the inhabitants in this endeavor.

Reconsidering Timna Site 39A Without Site 39B

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In the absence of absolute dating, published interpretations of the relative stratigraphy of Timna Sites F2 and 39b were incorrect. Indeed, radiocarbon and more recent geomagnetic archaeointensity dates have overturned other published views on the earliest metallurgical sites in the region. Even so, it needs to be borne in mind that the selection of samples for study is critical. There seems more value in recovering samples for further study from the archives of the earlier excavations rather than selecting surface samples remaining on sites years after excavations. The radiocarbon and archaeointensity dates for Site 39b, for example, document a mixed context, with just a few early dates, so 39b cannot now provide much meaningful evidence now for the Chalcolithic period.

Unlike the original publication in 1978 by Beno Rothenberg, where Sites 39a and 39b were conflated, this presentation reconsiders Timna Site 39a, separately from the confusing material from Site 39b. In view of the single radiocarbon date of 5485 +- 45BP (calibrated to 4460 BC) for charcoal from find boxes for Locus 1 of Site 39a, which supports the Chalcolithic date proposed by Rothenberg, new archaeometallurgical samples were selected from the find boxes in storage from the 1965 excavations of Locus 3 at Site 39a. During the selection of slag samples for the new investigation, crucible fragments as well as smelting furnace fragments were also documented among the material in the original find boxes. These new samples were not included in the original IAMS monograph *Chalcolithic Copper Smelting, Excavations and Experiments* (Rothenberg et al., 1978). Additionally, recent excavations of new loci at Site 39a in June 2005 produced further samples of slag for analysis. The objective of the new analytical work on these samples is to focus exclusively on the dated metallurgical remains found at Site 39a. Provisional results indicate oxidised, Cu-rich slags, which would be consistent with, but do not prove, a Chalcolithic origin. In future, a distinction should be made between "Site 39a" and "Site 39b" and they should not be grouped together. Forthcoming absolute dates, hopefully available by the Congress, should shed more light on these controversial issues.

Beno Rothenberg and The Chronology Of Copper Smelting At Timna

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Back in 1984 I published my interpretation of the chronology of copper smelting at Timna and of the hypothesis that the copper mines and the copper smelting installations at that site could be identified with the fabled "Copper Mines of King Solomon" [J. D. Muhly, "Timna and King Solomon", *Bibliotheca Orientalis* 41 (1984) 275-292; being a 'Review Article' of *Antikes Kupfer im Timna-Tal. 4000 Jahre Bergbau und Verhűttung in der Arabah*, eds. H. G. Conrad and B. Rothenberg, Bochum 1980 (*Der Anschnitt*, Beiheft 1). This review was published at a time when there was a great deal of interest in "King Solomon's Mines" and in the popular books that Rothenberg had published on that subject, especially *Were These King Solomon's Mines. Excavations in the Timna Valley* (Stein and Day 1972).. It is fair to say that my review convinced many scholars and infuriated many others. It was also written years before the great surge of scholarly interest in dating the reigns of Solomon and David and the re-interpretation of the historical reality of an "Age of Solomon" in the 10th century BCE.

The occasion of this conference, held in memory and appreciation of the pioneering contribution that Beno Rothenberg made to the field of archaeometallurgy through his work at Timna and in Spain, and to the education of future scholars in the field with the establishment of the Institute for Archaeo-Metallurgical Studies at the Institute for Archaeology, University College London, to be held on-site at the Timna Park, seems to me to be an excellent opportunity to take another look at outstanding questions regarding Solomon and Timna. The proper treatment of all the issues involved, and the extensive recent literature, demands a scholarly monograph, but I hope to be able to call attention to some of the central issues and to highlight how our understanding of every aspect of the controversy has changed due to the scholarship of the past thirty years. I feel that Beno would be delighted by the on-going interest in almost every aspect of his scholarly career.

Timna Site 34: Applied Archaeomagnetic Experiments and Excavations

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As part of the Central Timna Valley Project of Tel Aviv University we conducted archaeomagnetic experiments on slag samples from Site 34 ('Slaves' Hill') and nearby slag deposits in order to further constrain the age of copper smelting in these sites. The experiments focused on reconstructing ancient geomagnetic intensities using the Thellier-Thellier method. The intensity values were compared to the regional archaeomagnetic reference curve and to published values from other sites in the Timna Valley. The results show that slag mounds on the hilltop of Site 34 represent one time span while slag mounds at the bottom of the hill are probably from different periods. The magnetic characteristics of the samples also indicate differences in smelting technologies between the mounds on the hilltop and those at the bottom of the hill. The intensity values of the slag from the hilltop correspond to the early Iron Age, similar to values previously obtained from Site 30. Furthermore, new results from nearby Site 30A corroborate Rothenberg's assertion of simultaneity of production with Site 30, giving further support to the claim of intense smelting in the central Timna Valley during the early Iron Age (11^{th} – 10^{th} centuries BCE).

Bronze Production In Pi-Ramesse: Alloying Technology And Material Use

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In the Late Bronze Age Egyptian capital Pi-Ramesse, a variety of high-temperature processes were conducted to produce bronze, glass, faience and Egyptian Blue, all of which required copper as a central ingredient. For this paper presentation, the bronze production facility is considered in more detail.

Large scale production of bronze was taking place in Pi-Ramesse, most likely during the development of the new urban centre to create architectural features and decorative objects such as large statues. Bronze production and recycling was probably also taking place at a smaller scale in multifunctional workshops which, after the urban development stage, were expanded and oriented towards the production and maintenance of a chariot army stationed in Pi-Ramesse. Through a study of crucible remains from the different production areas on site, a picture of technology and material use is reconstructed.

This paper will discuss the latest results of this technological study against the background of contemporary copper production in Timna, connected to Egyptian presence in the region, and expand on the implications for our understanding of copper trade in this period.

Nahal Tsafit; A Middle Timnian Site, Ca. 4000 Bc, On The Road From Feinan To Beersheva

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Excavations at Nahal Tsafti, on the Rotem Plain in the northeastern Negev and on the road between Feinan and Beersheva, have revealed a Middle Timnian site dated by radiocarbon to the late 5th millennium BCE. As such, the site offers insight into the developing relations between the desert and sown during the protohistoric period, especially as relates to the copper trade.

Investigations at the site focused on two components, excavations of the habitation remains at the base of the escarpment and survey of a large tumulus field on the upper plateau. Excavations revealed an architectural complex typical of the Timnian cultural complex, consisting of at leas tone round hut base and apparent closure walls. Stratigraphy shows accumulated remains suggesting repeated occupations sealed ultimately by slope colluvium and alluviation. Survey on the plateau overlooking the site documented a field of 116 tumuli, all located along the cliff edges and visible in silhouette from some distance. The tumuli are the typical massive cairns known from some sites dated to the 6th and 5th millennia, and perhaps as late as the Early Bronze Age. In addition, two wall shrines, aligned roughly toward the summer solstice, were also documented.

Along with the architecture, the material culture assemblage links the site clearly to the Timnian cultural complex. In particular, diagnostic elements of the lithic assemblage include triangular transverse arrowheads, microlithic drills, tabular scrapers, and a large ad hoc tool assemblage. Ceramics include a large hole mouth storage vessel found intact and in situ, but lacking both rim and base. Finds of special interest include a hematite pebble and a broken macehead of limestone, a clear link to the Ghassulian Chalcolithic.

Food And Culture In Smelting Sites: A View From Timna

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Animal remains reflect in most cases the food of past societies. Apart from the immediate caloric value, the choice of what to eat, and how, may have symbolic and political-economic meanings and play a role in social identity. In order to discern the social identity of Timna inhabitants and their interaction with neighboring smelting sites during the Late Bronze / early Iron Ages (1300 – 900 BCE), we studied recently excavated faunal remains from Timna.

Studying new faunal assemblages from sites 30 and 34 at Timna adds to previous publications from that region (Timna sites 200, 30, 2) and recent archaeozoological research from Faynan. Comparing to numerous studies on the Iron Age economy in the southern Levant, allows us to gain insight into the economy and social identity of the site workers/inhabitants. In addition to isolating unique attributes of industrial contexts (particularly those of metal production), the study intend to shed light on the interaction and relationship between the societies of the contemporaneous smelting sites in Timna and Faynan. Preliminary results from seasons 2009 and 2013 reveals that livestock animals – sheep, goats and cattle dominate the assemblage, similarly to sites from Faynan and from ancient Israel as well. Examining the range of fauna exploited – the domestic livestock and wild fauna - as well as the way of exploiting it, ways of obtaining meat and methods of preparation for consumption or other uses, serve as the basis for comparison and additional, more refined insights.

Metal finds from Nahariyya Excavations

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An assemblage of 29 metal finds was recovered during salvage excavations conducted at Balfour Street in Nahariyya. The excavation, carried out on behalf of the Israel Antiquities Authority was directed by N. Getzov and Y. Lerer. This group of metal finds included: daily use objects (iron knifes, fishing weights {lead} and nails), luxuries (two spatula and fibulae) and weapons (mainly Irano – Scythic arrowheads).

The metal finds were dated by the excavators to the Persian period. This assemblage from Nahariyya is considered one of the well-dated metal groups from the Persian period: According to the excavators, the metal objects are assigned to two main periods: the finds from Stratum V–VI, are dated between the 6th till the beginning of the 5th century BCE, while finds from Stratum IV–II are dated to the 4th century BCE.

In addition to typological examinations, all the objects went under chemical analysis in purpose, to check the possibility, of dating metal objects by chemical analysis (XRF).

Preliminary observation shows some differences in the chemical composition of the objects from 4th and 6th century B.C:

- Objects dated to the 6th century B.C (mainly arrowheads) include Antimony (sb), that do not exist in the 4th century B.C objects tested in this research. Needles, made from tin bronze without any use of antimony.
- Spatula dated to the 4th century B.C include an amount of up to 11% of tin while a spatula dated to the 6th century B.C include an amount of less than 10% tin . This 1% difference of tin is not significant. On the other hand, the amount of lead in the 6th century B.C objects (between 3% – 7%), is higher than the objects from 4th century B.C (less than 1% of lead).
- Fibulae dated to the 6th century B.C include an amount of up to 12% tin, while the founds from the 4th century include an amount of less that than 12% tin.
- The two fibulae dated to the 6th century B.C include an amount higher than 5% of lead, while most of the fibulae from 4th century include an amount that less that 1% Of lead.
- Two arrowheads from the inland (Tel Hadid) dated to the 5th century B.C include a high amount (7.4% - 14.3%) of antimony.

The existence or absence of antimony can indicate the difference between local or imported objects, since the local minerals in Israel do not include antimony. These results, correlate with the historical resources describing the Persian conquest of the area in the 6th century B.C. This could suggest that arrowheads that include antimony belong to the foreign forces of the Persian army, while the other objects can be considered as local products.

The results of this research must be considered preliminary, due to the absence of good parallels: no such tests or research has been conducted yet in other sites, dated to the Persian period. In addition, in most archaeological sites excavated during the last century, the objects are generally dated to the Persian period without a possibility to determine a specific period such as the case of the Nahariya excavation in 2005.

These results, lead to the conclusion that such research should be completed. The first step is to create a data base from such archaeological excavation with good and exact dating. Only after completing the data base, the chemical analyses can be compared to determine the difference between periods and materials.

Compositional Analysis Of Slags From Nahal Amram

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The research in Nahal Amram headed and conducted by **Uzi Avner, Hanan Ginat, Rahamim Shem Tov and Boaz Langford**, is giving us a rare opportunity to study part of the ancient copper production in a specific place with two major and well defined production periods, and without the need to reevaluate earlier well established hypothesis as well as historical and technological reconstructions, as, for example, in the well-known case of nearby Timna.

The two main archaeological periods of copper production in Nahal Amram as recorded by the field survey (and detailed in other papers in this symposium) are from two major periods:

- Relatively small size slags – dated to the end of the Late Bronze Age – Iron Age (circa 13th – 9th centuries BCE)
- Relatively large size slags – dated to the Islamic period (circa 7th – 11th centuries AD).

Preliminary X rays Florescence Analysis (XRF) of some of these two types of slags, show, as expected, a different smelting technology, this difference could be easily identified by the different Iron to Copper ratios as well as with some typical trace elements consecrations. The "older" slag type ((circa 13th – 9th centuries BCE) show in general 25Wt% Fe and 5Wt% Cu = ratio of 5 / 1. The "late" production (circa 7th – 11th centuries AD) show in general 25%Wt Fe (as well) but an average of only 0.5Wt% Cu = ratio of 5 / 0.1, ten times less Cu left in the slag and therefore a much better metal benefaction during smelting, then in the earlier production.

Above that, the Islamic slags (7-11 AD) show a relatively high content of Zn (slightly less than the amount of Cu in the slag), when the content of Zn in the "older" slags (13-9 BCE) is significantly lower. Zn was not found in the few samples of ore we analyzed from Nahal Amram, but was detected in one "green" sample that is definitely not an ore but an iron mineral (mainly Fe) with some amount of Zn and significant amount of Rb (a metal detected as well in several samples of Islamic slags). This Fe mineral could have been used as a flux during the late Cu production in Nahal Amram and by that "donating" the Zn traces to the slag.

In conclusions: the validity of all the above preliminary results is highly doubtful and would be proved to be right (or alternatively, proved to be totally wrong) only with further detailed analyses. Only after concluding the next step we would be able to compare the results with the data from bigger and more complicated sites as Timna, as well as the data from small and "short living" sites like Ein Yahav, Sapir, Yotvata etc. Only after that, we will be able to start reconstructing the overall copper production history in the Arava region.

Excavations Of The Sinai-Arabah Copper Age – Early Phase (Chalcolithic) Mine T In The Timna Valley

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The Southern Arabah, the Timna Valley in particular, is a unique museum for the history of mining. Here, preserved in one area, lies the evidence for almost all periods of mining, from some of the earliest known copper mines on earth, dating to some time in the 6th-5th millennium BC, right up to the modern day copper mines. The interesting and unique feature of this preservation is that each subsequent period of work in the area has left at least some of the mines of its predecessors undisturbed or very little disturbed.

The earliest mines yet investigated in the Timna Valley date to the 'Sinai-Arabah Copper Age - Early Phase I' (Late Pottery Neolithic period). These mines were 'pit mines' in relatively unconsolidated material, recovering eluvial copper ore nodules.

The next period of mining could be dated to a late stage of the Sinai-Arabah Copper Age – Early Phase II (Chalcolithic, 5th-4th millennium BC). There are numerous well-preserved mines of this period, though in some cases there was a later overlay of workings by Egyptian New Kingdom mining expeditions of the 14th-12th centuries BC, and, sometimes, by the Romans and even later workings. These are the first true underground mines, with quite

extensive networks of underground workings, connected to the surface by numerous short shafts. One set of such workings, Mine T, has been excavated and investigated and these are the focus of this publication. It is possible that this mining phase continued intermittently through to the end of the Chalcolithic period.

In 1974-76, the first excavations at the Timna mines by the Arabah Expedition were directed by H.G. Conrad, director of the German Mining Museum Bochum (Conrad and Rothenberg 1980), including mine workings in Area T. In 2001, further excavations were undertaken in Mine T, directed by Beno Rothenberg and supervised by Alexandra Drenka, (Drenka 2003), further investigated in 2002 by C. Tim Shaw and Alexandra Drenka. These were the last excavations in Timna directed by Beno Rothenberg. The paper covers both, the excavations and investigations of 1974/6 and 2001/2**.**

How Is World Heritage Site Used As A Tool For Nature Preseravation And Toursim Promotion?

Timna Valley As A Case Study For Decision Makers

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This study examines whether UNESCO's declaration of World Heritage Sites serves to protect sites of natural and heritage value in Israel, and assesses the extent to which World Heritage Site status promotes tourism. The findings, analysis, and conclusions reached in the study offer a tool for decision makers, before they continue work on the other sites in Israel such as Timna.

The study employed a qualitative method of data collection and analysis. The methodology used–"grounded theory terrain"–prescribes gradual progression from one interview or field observation to the next, with each step providing a piece of the puzzle of trying to answer the research questions. As data collection progressed in the present study, findings were classified and organized into main themes in order to facilitate the formulation of discussion and conclusions. Findings were processed in accordance with Gibton's method for qualitative studies (2001). The transcripts of the initial and gross data were processed in five stages, beginning with their entry into the word processor and concluding with the formulation of major themes. The work included the structuring of 20 initial categories out of the content to **the four main themes formulated in the course of the study: 1) the statutory standing of sites, 2) site management, 3) tourism, and 4) international organizations.**

Perhaps most significant with relation to the **first theme** is the fact that World Heritage Sites were found to have **no statutory** standing within the state of Israel, a fact with direct bearing on the protection of heritage and nature sites in the country. Sites that had already been declared World Heritage Sites had not been assigned a unique legal status to protect them from damage. In addition, no special attention had been paid to such site by the state planning authorities.

The **second theme** discussed in the study is **site management**. Study findings indicate serious deficiencies, and in some cases outright omissions, in the management of some World Heritage Sites in Israel. The protection of these resources did not improve after they were declared World Heritage Sites, and site management did not change

The **third theme** is tourism. In most Israeli World Heritage Sites, no increase in the number of visitors was observed following the declaration and no additional tourism infrastructures were constructed.

The **fourth theme** of the study is international organizations. There is a big lack of collaboration poses a threat to all World Heritage Sites in Israel, as well as to the mechanisms of conservation and supervision.

The findings generated by the study can be applied to the Timna Valley. This study's final conclusion is that UNESCO's declaration of World Heritage Sites does not necessarily serve to improve the protection of heritage and natural resources. World Heritage Site status also does not necessarily serve to improve tourism development. Based on the analysis of the data collected at the national level and in light of the nature of the system of World Heritage Sites in Israel, **this study suggest to deduce that working to have the Timna Valley included in the World Heritage Site nomination list is not worthwhile, as such classification by UNESCO guarantees neither improved protection of natural and heritage resources nor enhanced tourism.** To prove so, it is necessary to research the current tourism at

the Timna Park and to understand the management policy of culture and nature protection and preservation.

Revisiting The Nahal Mishmar Hoard's Place In The Chalcolithic Near East

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The Nahal Mishmar hoard of copper objects dates over 6000 years old. This fascinating collection of complex copper alloyed artifacts has been studied for years but no complete comparison of their composition has been previously undertaken. Handheld XRF was used to collect compositional data for the entire collection of over 400 artifacts. The data is used to compare to the resent investigation of ceramic core petrography. Issues addressed include surface contamination and corrosion and dealing with a high alloy composition and potential elemental segregation.

The Inscription Of Ramessesempere In Context

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On an expedition to the mines of Timna, the expedition leader Ramessesempere commissioned a relief depicting the reigning king, Ramesses III, offering to Hathor, patroness of the mine. As at many other mining sites, the expedition leader added his own name to the relief, sharing the prestige and blessings of commemoration in stone.

In Egypt, the names of officials were generally not added to royal monuments, and this phenomenon is normally considered a way in which officials aggrandized themselves when far away from state supervision.

Nonetheless, also in Egypt officials sometimes added their names to royal monuments. This paper will investigate the significance of this behaviour, at home and abroad.

Ramessempere was also known as Ben-Ozen, a Semitic name; his father also seems to have been from the Levant. This lecture will locate him in a long tradition of foreigners and people from mixed families who were involved in Egyptian mining expeditions.

Copper Mining and Smelting in The Bronze Age – New Evidence From Mine Sites Including Some Re-Analyses Of Dates and Ore Sources

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Over the past 20 years some twelve sites of Early-Middle Bronze Age copper mining have been identified within the UK as a result of archaeological excavation and the radiocarbon dating of firesetting remains, bone and antler mining tools. This evidence suggests a fairly widespread phase of small-scale mining and prospecting for local ore sources within the coastal and upland areas of western Britain beginning around 2000 BC and finishing around 1500 BC; the end of this coinciding perhaps with the opening-up of new deposits of chalcopyrite ore in the Alps and import of metal from Europe. Current re-examination of some of this data (including that obtained from smelting remains) has since provided us with a more realistic model of the mining process, the types of ores extracted, and the strategies of prospection, which begin with the Beaker phenomenon in Britain and Ireland.

Ancient Mining in Gold-Silver-Copper Deposits and Metallurgical Activity in Mavrokofi Area, Pangaeon Mount (Ne Greece)

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The Pangaeon mountain in northeastern Greece was mentioned by Herodotus (5th century BC) among other ancient writers as one of the richest gold prospecting sites. This is evidenced by vein and shear-hosted precious and base metal deposits hosted in the rocks of Pangaeon. The ores at the central-eastern part of the mountain contain Fe, Pb, Zn, As, Cu, Ag, Au and substantial quantities of W, Bi, and Sb related with various mineral assemblages including pyrite, arsenopyrite, galena, chalcopyrite, sphalerite as well as minor bismuthinite, tetrahedrite, malachite, limonite and rutile. The ore at the western part of Pangaeon contains Fe, Mn, Pb, Zn, As, Cu, Ag, Au and minor Cd, Ba and Sb. The deposits are related with the hydrothermal activity associated with the intrusion of a granodioritic magma in the Pangaeon marbles and amphibolites.

The present research is based on detailed geological mapping and archaeological survey in the ancient mines and smelting sites at the wider area of the Pangaeon mount. Twenty five adits were explored, mapped and studied during a 4-years survey. Metallurgical slags from fourteen smelting sites were taken for comparative analysis with the mines' extracted material.

At this study we focus on the mine of the Mavrokorfi area, one of the mountain's highest peaks. Ancient mining techniques were studied and samples from the **gold-silver-copper ore** deposit were microscopically studied and chemically and isotopically analyzed. The mining activity is dated from the Roman to Ottoman times. Slags from an adjacent smelting site were studied in comparison with the Mavrokorfi ore deposit. The samples from the ore deposit and the metallurgical site were isotopically analyzed. Preliminary results imply multi temporal gold and silver exploitation with secondary extraction of copper at Roman times.

The Great Orme Bronze Age Copper Mines In Wales: Ore To Metal Provenancing Opportunites

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The Great Orme copper mines in North Wales are the largest known Bronze Age copper mines in Britain and are amongst the largest in Europe. The current research programme aims to resolve the apparent confusion in the literature as to the type(s) of metal these mines were capable of producing by undertaking an extensive analysis programme of ore samples collected in situ, excavated smelting residues and materials from smelting experiments. The survival of many kilometers of tunnels dated to the Bronze Age and contemporary opencast workings present an unusual opportunity to study in situ the ore geology and ore/gangue mineralisation, which allows the probable ore types extracted to be deduced. Systematic sampling has begun of the ores from numerous sites in the extensive workings with the aim of establishing their geochemistry and, in particular, the variation within and between the various mineralized zones. The fragmentary remains of the only known Bronze Age smelting site in Britain were discovered close to the mines and detailed studies are being undertaken on the slag and metal residues excavated in 2011. Ore samples will also be used for smelting experiments to establish the partitioning of key minor or trace elements between metal and slag. A variety of analytical techniques are being applied to the ores and smelting residues (ore microscopy, SEM-EDS, AAS, ICP-MS, XRF, LIA). All these new data will be evaluated against the recently compiled OxSam database of British Bronze Age metalwork analyses to assess the contribution of the Great Orme to the metal supply and the implications of this to current research on Bronze Age exchange networks. This interdisciplinary project is still at an early stage, but the methodology is starting to yield some interesting initial observations.

Copper Ingots From The Southern Levant As Indicators Of Diverse Trade Networking; A Study Of Their Chemical And Isotpoic Composition And Microstructure

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Hundreds of ingots were found in under water excavations off the Carmel coast, Israel. One group from Kefar Samir, dated to the Late Bronze Age, included, inter alia, fragments of oxhide ingots. Another group found near Neve Yam, dated roughly to the late second –early first millennium BCE included dozens of bun-shaped ingots. The chemical and isotopic composition and the microstructure of copper ingots from these two sites were studied and compared with smaller plano-convex ingots recently unearthed at Late Bronze Age Hazor. The results showed that ingots from the three sites differ in their mode of production, the degree of refinement and origin of the copper. The ingots from Hazor were made of 'black copper'. Technologically they are similar to ingots from Timna, however LIA precludes their origin in the Arabah. The ingots from Kefar Samir correspond -well with other oxhide ingots found around the Mediterranean. The ingots from Neve Yam have LI ratios which are consistent with LI ratios of copper from both Timna and Faynan. Their relatively high lead content renders Faynan as their likelier source. The ingots thus represent different trade networks, which involve the Arabah, Cyprus and possibly Anatolia.

Timna Chariots' Engraving – A Reassessment

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In 1960 Beno Rothenberg's team had discovered at mine 25 in Timna a large graffiti depicting an elaborate scene, in which the most impressive images are those of horse drawn chariots. In his 1972 "Timna" publication Rothenberg described the incised engraving as containing two different main themes: a processional array with some cult or magic significance, and a hunt. He noted a difference between the human figures depicted in the scene which he interpreted as probable Egyptian charioteers and Midianite hunters. Later (in 2003) he proposed understanding the Midianite hunters as representing an early wave of migrating Philistines "collaborators of the Egyptians in the New Kingdom copper industry of the Arava". Concurrently Emmanuel Anati suggested (in 1979) that the engraving has four to five chronological phases which depict a funeral procession for a distinguished person, and a hunt scene.

The current paper will survey earlier interpretations of the engraving, propose new understandings, and discuss the historical context of this monument.

Transgendered Copper Mining In The Levant

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From the Late Bronze to Iron I, Egypt exploited metallurgical activity in the region of Timna. Apart from the archaeological record, Timna appears in the genealogical lists of Gen 36 and 1 Chr 1 as a son, a sister, and a concubine. If the Biblical name Timna functions as a personification of the region and its inhabitants, then one cannot help but think that the change in gender and marital status of the figure Timna is directly linked to the fortunes of the copper mines in the region Timna. But the composition of sources in Gen 36 and 1 Chr 1 significantly post date the heyday of Timna copper mining which leaves the question as to why they would preserve all three status markers instead of simply referring to Timna as the lowest, a female concubine, given the paucity of mining operations for the site during Iron II. This preservation likely indicates a social fluidity for the region and its inhabitants that is more complex than just a loss of status as the mines were depleted. Timna's social development reflected in the Biblical genealogies followed the heterarchy model[1] as it formed alliances with surrounding Canaanites and later Israelites.

Ultimately, the different genealogical designations of male, sister, or concubine were created at a moment in time when the politico-economic situation warranted it. We cannot pinpoint that exact time because each designation was recycled as politico-economic situations changed. This study only outlines the meaning of male, sister, and concubine in the genealogies and not when they were originally composed. The later Biblical use simply reinforces the politico-economic situations indicated by archaeological data and other textual sources giving us insight into how genealogies functioned in Israelite culture.

[1] Graham Philip, "The Early Bronze Age I-III," in Jordan: An Archaeological Reader, ed. Russell Adams (Oakville, CT: Equinox, 2005), 165.

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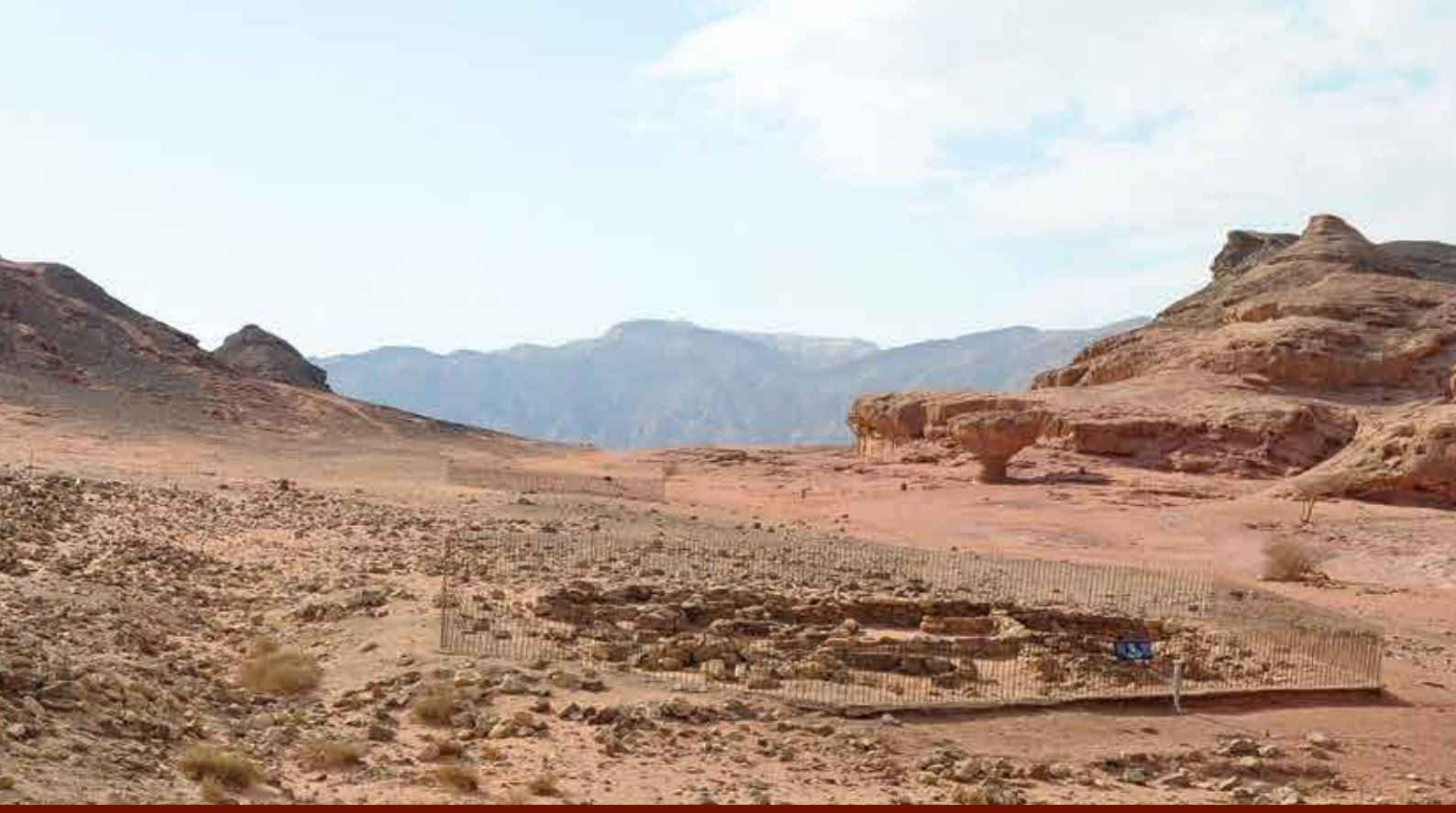

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