Making Sense of a Distribution of Dates

Luminescence Dating of Pottery from the Turkish Black Sea Coast

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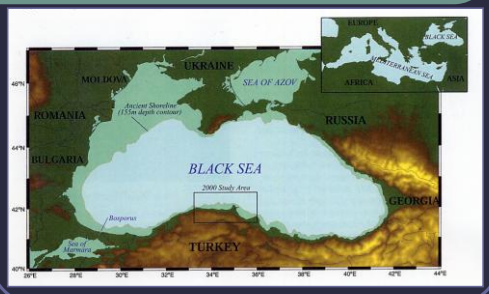
Presentation Outline

- I. Project Background and Goals
- II. Basic Methods and Results
- III. Evaluation of Data I: Luminescence
  - Alpha Efficiency and b-Values
  - Qualitative 'grades'
- IV. Evaluation of Data II: Typology
  - Multi-component sites
  - Sample size

Project Background

The Sinop Regional Archaeological Project (SRAP)

Study Area



Port Settlement

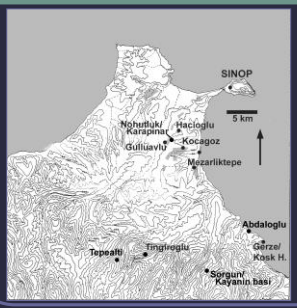
SRAP Objectives

- Understand how the Black Sea region of Turkey relates to other regional centers
- "Seeking Connections" by establishing:
  - A refined technologically-based typology of Neolithic-Iron Age ceramics,
  - The distribution of types and technological traits through the Sinop promontory, and
  - **A systematic luminescence chronology**

General Question

- How do absolute luminescence dates compare to typological dates?
  - Are existing regional ceramic typologies accurate in the Sinop promontory?

Sinop Promontory



Iron Age
- Tıngırtepe
- Nohutluk
- Tepealtı
- Köşk Hoyuk

Bronze Age
- Kayanın Başı
- Kocagöz
- Güllüavlu

Chalcolithic
- Karapınar
- Abdaloğlu
- Hacıoğlu

Neolithic
- Mezarlıktepe

Sinop "Neolithic" Ceramics

Basic Methods and Results

UW Luminescence Laboratory

OSL (and IRSL) Dating of Ceramics

- Better precision and accuracy through independent lines of evidence = weighted averages
- Alternative – and supplement – to TL results, which may 'fade' …
- D_E from both TL and OSL

Dating Fine-Grained Ceramics

- Fine-grained = polymineral
  - Problem: **Anomalous fading** of feldspar component
    - Loss of charge resulting in a decrease in dose-related luminescence over time.
  - Need to eliminate feldspar from OSL analysis … Double SAR

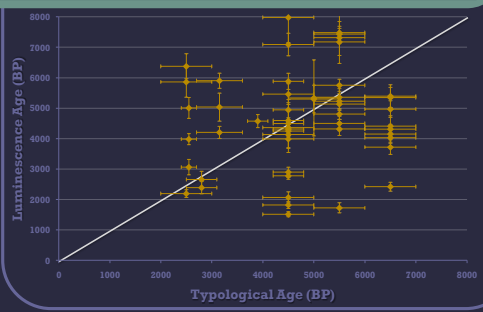
Double SAR and Fading

- SAR = Single Aliquot Regenerative dose
- 'Double' = IRSL and OSL
  - Circumvents problem of anomalous fading
    - IR exposure **may** remove feldspar signal from OSL
    - Only feldspar is sensitive to IR

Dose Rate

- Beta dose rate calculated in two ways
  - Direct beta counting
  - Derivation from alpha counting
    - Assumption of secular equilibrium
    - K content from flame photometry

Typological vs. Luminescence Age: All Ceramics



Evaluation of Data

Discrepancy due to poor luminescence data?

Explaining Discrepancies

- Luminescence results are inaccurate
  - OR
- Typology is inaccurate
  - OR
- Both are inaccurate

Double SAR

- Should circumvent problem of anomalous fading
- BUT, don't know if IR eliminates ALL of the feldspar signal … so …
- Implemented a pulsed-OSL application

Pulsed OSL

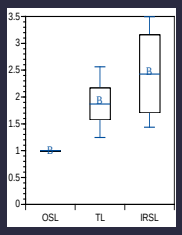
- Takes advantage of the **time** between *stimulus* and *emission* of luminescence energy
  - Feldspar is 'fast': ~10 microseconds
  - Quartz is much slower, mostly after 10 microseconds
- ∴ 10 microsecond 'pulse' of light stimulation should eliminate feldspar and preserve the quartz

Pulsed OSL

- Results show that pulsed D_E is same as non-pulsed D_E
  - So, Double SAR probably eliminates the feldspar, *i.e.* pulsing was redundant
    - But, full disclosure, the error terms were quite large and small signal
      - No feldspar?
- But, this does not agree with SRAP **b-value** data …

b-value

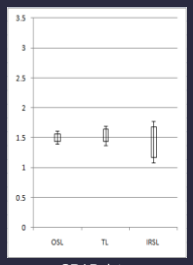
- b-value: ratio of luminescence response (β:α) used to correct for reduced *α* **efficiency:**
  - Because α's are less effective at producing luminescence than β's or γ's
  - *α's* more efficient for IRSL (predominately feldspar), followed by TL (assortment of feldspar and quartz) and OSL (mainly quartz)



Data presented at 2006 New World Luminescence Meetings

Observed b-values

- BUT, some SRAP OSL quartz b-values have been anomalously high, approaching feldspar levels.
- AND, pulsed data agrees with Double SAR – did not lower the high b-values
  - Same results pulsed and non-pulsed
- High b-values remain unclear



SRAP data

Resolving the High b-values

- Does OSL fade? High b-val suggest feldspar component, but high OSL:IRSL ratios suggest little fading

- No correlation between high b-val and low OSL:IRSL ratio

Summary

- So, anomalous fading addressed via:
  - Double SAR
  - Pulsed OSL
  - b-values and OSL:IRSL ratio
  - → Fading is not an issue, but difficult to explain high b-vals
- But, what of the problem of TL and OSL disagreement?

TL, OSL (dis)agreement

- 65 % of sample with agreement between TL and OSL
  - Corrected TL data
- What can we say about the equivalent dose data when TL ≠ OSL?
  - Can't all be explained by fading
    - TL<OSL
  - TL>OSL, poor firing?
- Prioritize the dates with agreement

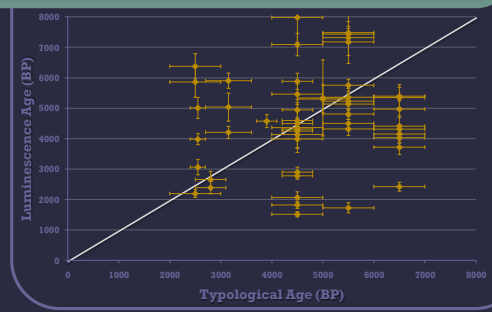
Luminescence Evaluation

- Associated Sediment
- Relative b-values: IRSL>TL>OSL
- OSL D_E Error of <15%
- TL D_E Error of <15%
- β Dose rate calculations from α are equivalent to calculation from β
- TL Plateau > 70 °C
- OSL Age = TL Age
- TL Fading
  - None or correctable

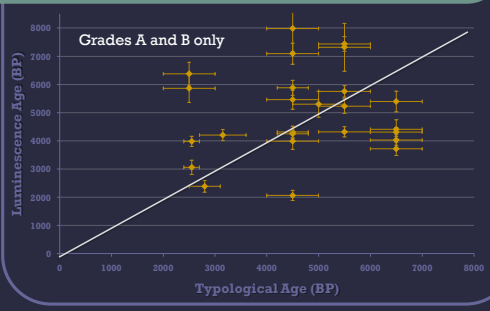
Grade Determination

- A: OSL=TL, and TL does not fade or can be corrected and passes all other tests
- B: OSL=TL, and fails just one test
- C: OSL=TL, but fails two or more tests <u>or</u> OSL≠TL
- D: OSL≠TL <u>and</u> more than two failures
- 40% of sample with Grades of A or B

Typological vs. Luminescence Age: All Ceramics



Typological vs. Luminescence Age: All Sites



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Typological Ages

Iron Age	Late Middle Bronze Age	Early Bronze Age	Chalcolithic	Neolithic
1.5 – 3.5 BP	3.5 – 4.0 BP	4.0 – 5.5 BP	5.5 – 7.5 BP	7.5 – 10 BP
Tıngırtepe Tepealtı Nohutluk Köşk Hoyuk	Güllüavlu	Kayanın Başı Kocagöz Abdaloğlu Karapınar	Güllüavlu	Mezarlıktepe Hacıoğlu

TL ages, Typology Independent

Iron Age	Late Middle Bronze Age	Early Bronze Age	Chalcolithic	Neolithic
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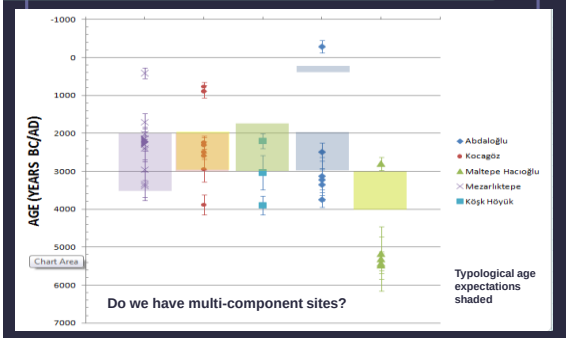
Kayanın Başı **Tepealtı**	Kayanın Başı Tıngırtepe	Kayanın Başı Köşk Hoyuk **Kocagöz** Güllüavlu Mezarlıktepe **Abdaloğlu** **Karapınar**	Kayanın Başı Nohutluk Kocagöz	Kayanın Başı **Hacıoğlu**

Intra-site Age Distribution



Intra-site Age Distributions, "Good Dates" only

Discussion

- Problem is partly with typology
  - Inadequate; luminescence is important
- When can we begin to characterize a site?
  - Especially ***multi-component sites***?
    - Distinguish from long occupation
  - How many dates do we need? What is a sufficient sample size?
  - Analogous to single-grain dating!

Summary

- Luminescence dates produce a revised Sinop ceramic typology
- Clarity of chronology (and strength of argument) increases with evaluation of luminescence dates
  - Lab analysis ≠ 'Black box'
- Adequate sample size per site must be defined