- **Expensive Tissue**
- **H. erectus** 1.8–0.4 ma
  - Africa = *H. ergaster*
  - Asia = *H. erectus*
  - Europe = *H. antecessor*

- **Key Sites**
  - Nariokotome 1.6 mya;
  - Java, 1.6-1.8 mya;
  - Dmanisi 1.75 mya;
  - Erk-el-Akhmar 1.7-2.0 mya; Longgupo 2.0 mya (?)

- **Migration v. Dispersal**
  - Climate & dispersal

- **Expensive Tissue Hypothesis and Feedback**

  - **Bipedalism**
  - **Stone Technology**
  - **Big Brain**
  - **Language** (organizational tool)
  - **Animal Protein & Fat**

- **H. ergaster**
  - KNM-ER 3733 1.75 mya
  - Range: 1.8–0.4 mya

- **H. antecessor**
  - Sima de los Huesos 400 ka
  - Range: 0.8–0.2 mya

- **H. erectus**
  - “Peiking Man” 0.5-0.2 mya
  - Range: 1.8–0.2 ka

- **H. erectus anatomy**
  - Thick brow ridges
  - Low sloping forehead and long skull
  - Wide skull base
  - Brain size 700-1100 ml
  - Modern post-cranial skeleton

Nariokotome Boy, 1.6 mya
West Turkana, Kenya
**Homo erectus**

Key Asian sites

- Nihewan & Zhoukoudian
- Longgupo

- Mojokerto
- Sangiran 1.6-1.8 mya
- Longgupo (?)
- Lantian/Gong-wanling
- Nihewan 1-1.2 mya

**West Asia**

- Erk-el-Akhmar 1.7-2.0 mya
  - paleomagnetic dates
  - Oldowan-like tools
  - ‘Ubeidiya ca. 1.4 – 1.0 mya
  - K-Ar dates & biostratigraphy
  - Oldowan/Acheulian-like tools

**Homo ergaster (?)**

- West Asia
  - Erk-el-Akhmar 1.7-2.0 mya
  - Erk-el-Akhmar 1.7-2.0 mya
  - Oldowan-like tools
  - ‘Ubeidiya ca. 1.4 – 1.0 mya
  - K-Ar dates & biostratigraphy
  - Oldowan/Acheulian-like tools

**West Asia**

- Dmanisi, Republic of Georgia
  - hominid mandible, cranial fossils and Oldowan-like tools
  - Ar-Ar date of ca. 1.8 mya
fossils from Dmanisi, Georgia ca. 1.8 mya

resembles…
*Homo ergaster*

Europe
- Gran Dolina, Atapuerca, Spain
  - crude stone tools and various hominid fossils >780 ka (paleomagnetic)
- *H. antecessor*
  - ancestor of neanderthals?

process of dispersal
- dispersal =
  - unintentional geographic relocation of individuals from a population
  - commonly associated with reproductive cycle and population growth
    - individuals expand into new areas to avoid competition with natal groups
  - ultimate geographic destination determined largely by extrinsic factors (barriers and corridors)
- migration =
  - intentional geographic relocation of a population

distribution of sites suggest a dispersal event shortly after appearance of *H. ergaster* 1.8 mya
Dispersal of *H. erectus*

- Climatic and environmental change
- New biological adaptations
- New cultural adaptations

- Climate change
  - Climate has fluctuated between extremes of cold-dry glacial, and warm-wet interglacial more than 20 times in past 2 Ma
  - Organisms try to keep pace with these changes by shifting their spatial distributions to where they feel “comfortable” (optimal habitats)

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**Glacial COMPRESSION**
- Biomes towards equator

**Interglacial EXPANSION**
- Biomes towards poles

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**Saharan Pump**

*Interglacial “sucked in”*  
*Glacial “pumped out”*
why only after 1.8 mya?
- something must be biologically different about *H. ergaster*!
  - bigger body size → bigger home range size
  - more efficient bipedalism → walk longer distances
  - better heat regulation → less tied to water sources

something different about behavior of *H. ergater*?
- Acheulian Complex
  - 1.8–0.15 mya
  - Africa, West Asia & Europe (not E. Asia)
  - greater control of tool manufacture → greater control of environment?
  - tool function?

East Asia and other areas lack hand axes!
- life in temperate environments…
  - controlled use of fire?
    - Swartkrans, 1.7 mya
    - Zhoukoudian (?) 500 ka
    - regular increase in habitual use after 400 ka
cooperation and language

- bigger brains →
- cooperation necessary to effectively compete with other large bodied carnivores?

Elephant hunting at Toralba & Ambrona, Spain now generally discounted… but planned scavening of elephant carcasses still needs coordination sophisticated hunting by 400 ka (first projectiles)

A Further Evolutionary Cascade

Bipedalism → Stone Technology

Big Brain

Language (organizational tool)

Animal Protein & Fat

1. big brain + small birth canal = neoteny
2. neoteny → greater infant dependence for survival
3. greater infant dependence → longer & stronger social bonds
4. longer & stronger social bonds → enhanced cooperation & dependence on social learning (i.e., culture)