



ICE - Exponential Functions

Tocharian is an extinct Indo-European language (see Figure 1¹ for a sample of the written Tocharian language). The language stands by itself as one of the eleven major groups that make up the Indo-European language family². Although an Indo-European language, Tocharian is remarkable in that it was discovered during archaeological excavations in Xinjiang Province in Western China during the 1970's and 1980's. (See Figure 2³ for a location map - the discoveries were made in the region covered by the shaded oval.)

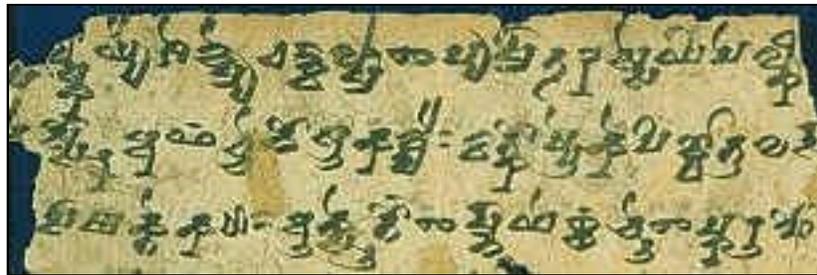


Figure 1: A fragment of an ancient Tocharian manuscript.

At least as remarkable as the discovery of manuscripts revealing a lost Indo-European language were human remains discovered during the excavations.



Figure 2: A map of China. The shaded oval region in the western part China is part of the Taklamakhan Desert, Xinjiang Province, where remarkable archaeological discoveries have been uncovered.

¹ Image source: <http://www.omniglot.com/>

² Source: Dickens, M. (1999) "An introduction to the Tocharian language." Available on-line from <http://www.wlc.com/>

³ Image source: <http://www.ecusd7.org/>

The region of Xinjiang Province where the ancient remains were discovered is part of the Taklamakhan Desert (see Figure 3⁴). This is an extremely arid region that is hostile to human life. These arid conditions rapidly dehydrate organic matter. Over a period of time, the extremely dry conditions will naturally mummify human remains. As such, rather than skeletons, the Chinese archaeologists discovered near perfectly preserved human remains that still had skin, hair, flesh and internal organs intact. As a result, it was a simple task to infer what these ancient people actually looked like.



Two examples of these mummified remains are shown in Figures 4 and 5⁵. Figure 4 shows a mummy that has become known as “Charchan Man,” and Figure 5 shows a mummy that is called the “Beauty of Loulon” because the body is so well preserved.

The existence of these mummies was not well known outside of Chinese archaeological circles until the late 1980’s, when sinologist Victor Mair discovered Charchan man displayed in a small museum in Urumchi, the capital of Xinjiang Province. (Victor Mair is a Professor of Chinese Literature in the Department of Asian and Middle Eastern Studies at the University of Pennsylvania.)

The mummies were displayed in cases so dimly lit that visitors to the museum had to use flashlights to see what was on display⁶.



Figure 4: Charchan Man.



Figure 5: The Beauty of Loulan

⁴ Image source: <http://www.shinyglobe.com/>

⁵ Image source: <http://www.discovery.com>

⁶ Source: Pringle, H. (2000) “Secrets of the red-headed mummies.” Available on-line from http://www.geocities.com/j_chandler21/mummies.htm

When they were finally able to view the exhibit, Mair and his associates were amazed by the clothing. Charchan man was dressed in a bright red tunic, and a pair of blue and red striped pants. What truly astonished Mair (who is an American of European descent) and his party was Charchan man's hair and face. His hair was ginger colored, and his face bearded with typical Caucasian features. As Mair observed, "He looked like my brother Dave sleeping there..."

Because of this Caucasian appearance, and because the mummies were found near the ancient trade route known as the "Silk Road" the remains were assumed to be the corpses of people who had died while traveling along this route.

- Organic matter contains a radioactive isotope of carbon, carbon-14. A 100g sample of fresh organic matter will normally contain 0.0001 μg of carbon-14. Carbon-14 has a half life of 5730 years. Find an equation that will give the amount of carbon-14 that remains in a 100g sample of organic matter that is T years old.**

- During the 1990's, Japanese researchers paid over \$100,000 to the Chinese government for 100g samples of these mummies. The amounts of carbon-14 found in these samples are shown in Table 1 (below). "The Baby" was a baby girl. Both "Charchan Man" and "The Beauty of Loulon" were adults (see Figures 4 and 5 above). Based on the data given in Table 1, could these three people have lived (and died) at approximately the same time?**

Mummy	Amount of carbon-14 found in 100g sample (μg)
The Baby	0.0000654
Charchan Man	0.0000695
The Beauty of Loulon	0.0000616

Table 1: Results of carbon-14 dating tests made at the University of Tokyo.

- **Use the information contained in the table to work out how old each of the three mummies is.**

- **The Silk Road was established after the Venetian traveler Marco Polo (1254-1324) made his historic journeys from Europe to the Far East (see Figure 6⁷). Is the theory that the mummies were unlucky travelers who dies on the Silk Road correct or not? Explain your reasoning.**



Figure 6: A portrait of Venetian explorer Marco Polo (1254-1324).

Note: The calculations that you have just completed are at the heart of a heated political dispute in China. Because the desert mummies have been shown to pre-date the Silk Road (the main route for trade between East and West in the ancient world) and because of their Caucasian appearance, some groups (notable among them the Muslim Uighurs) living in western China feel that they are part of a distinct ethnic and cultural group, and should not be subject to rule by the Chinese government in Beijing.

⁷ Image source: <http://www.silk-road.com>