

# Energy Choices: Is Climate Change in the Equation?

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## Energy Choices:

### Is Climate Change in the Equation?

An all-important, but poorly grasped factor  
in the equations of BOTH

Peak Oil -

the crisis of diminishing global oil supplies

and

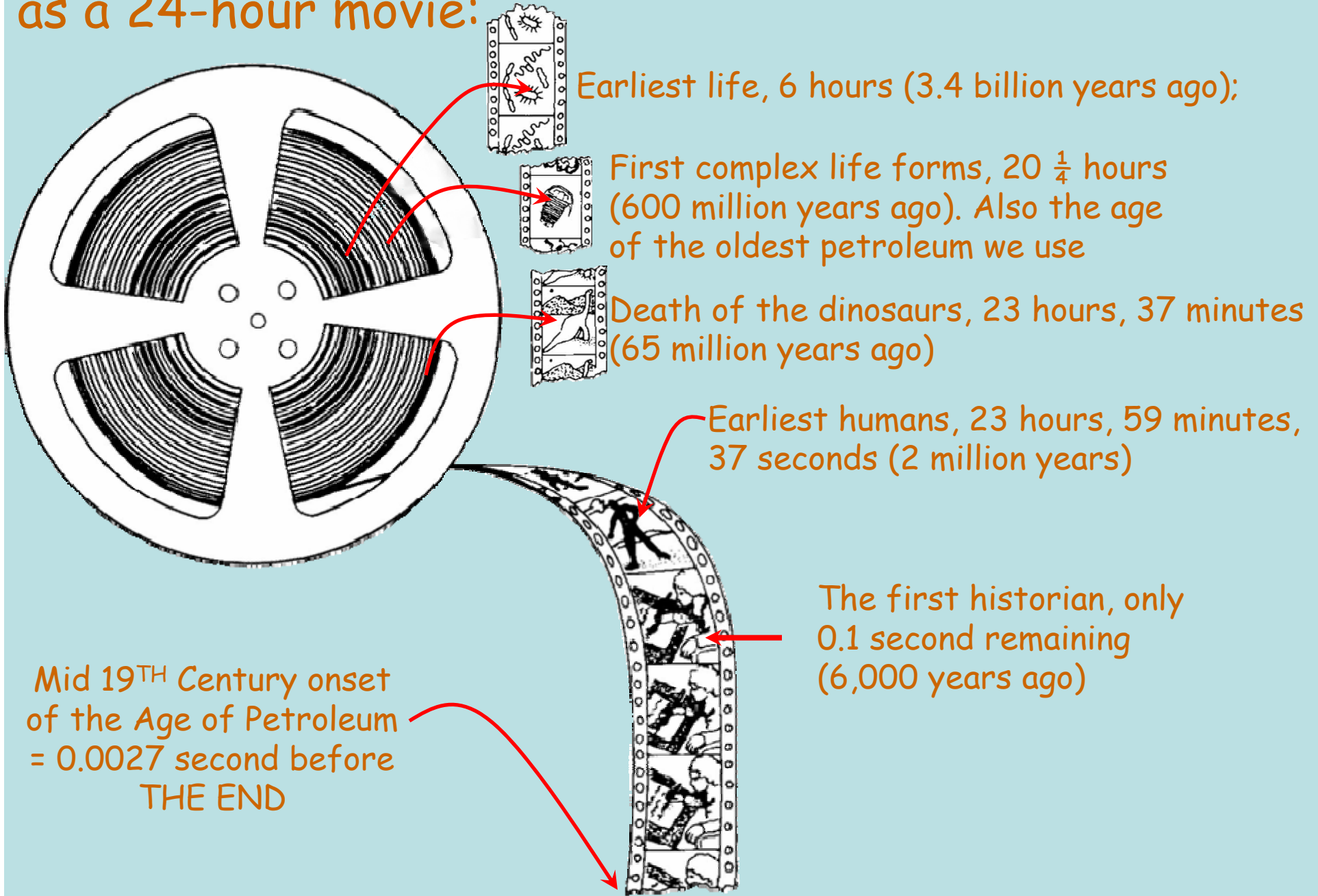
The crisis of Global Warming

Is the vastness of GEOLOGIC TIME

compared to

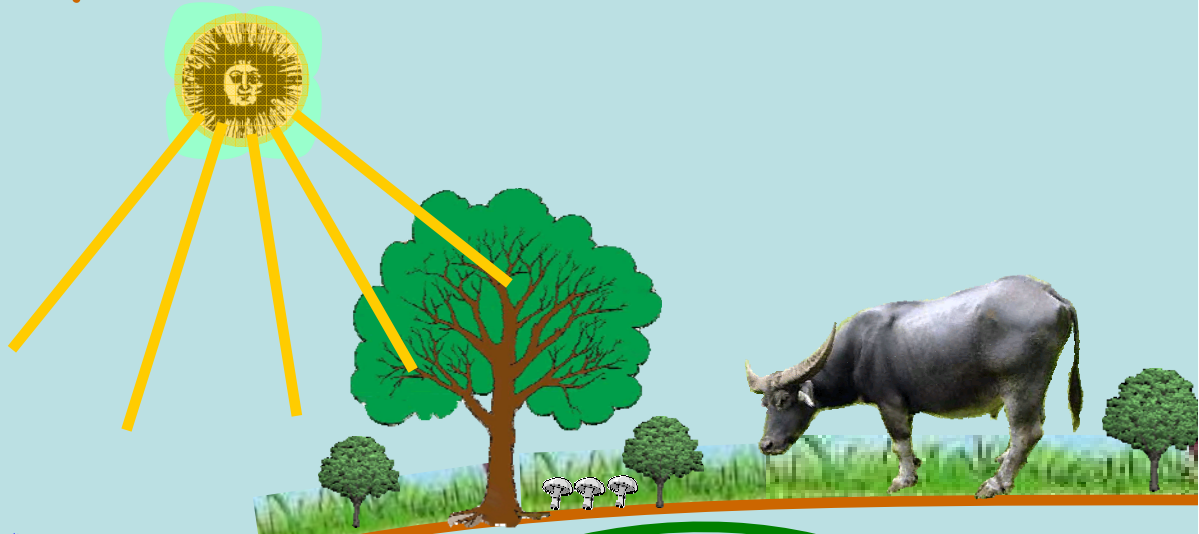
HUMAN TIME

If Earth's complete  $4 \frac{1}{2}$  billion years were shown as a 24-hour movie:



# The Grand Cycle of Life Materials

The Photosynthesis-Consumption loop is almost perfect ...



Microscopic algae and diatoms



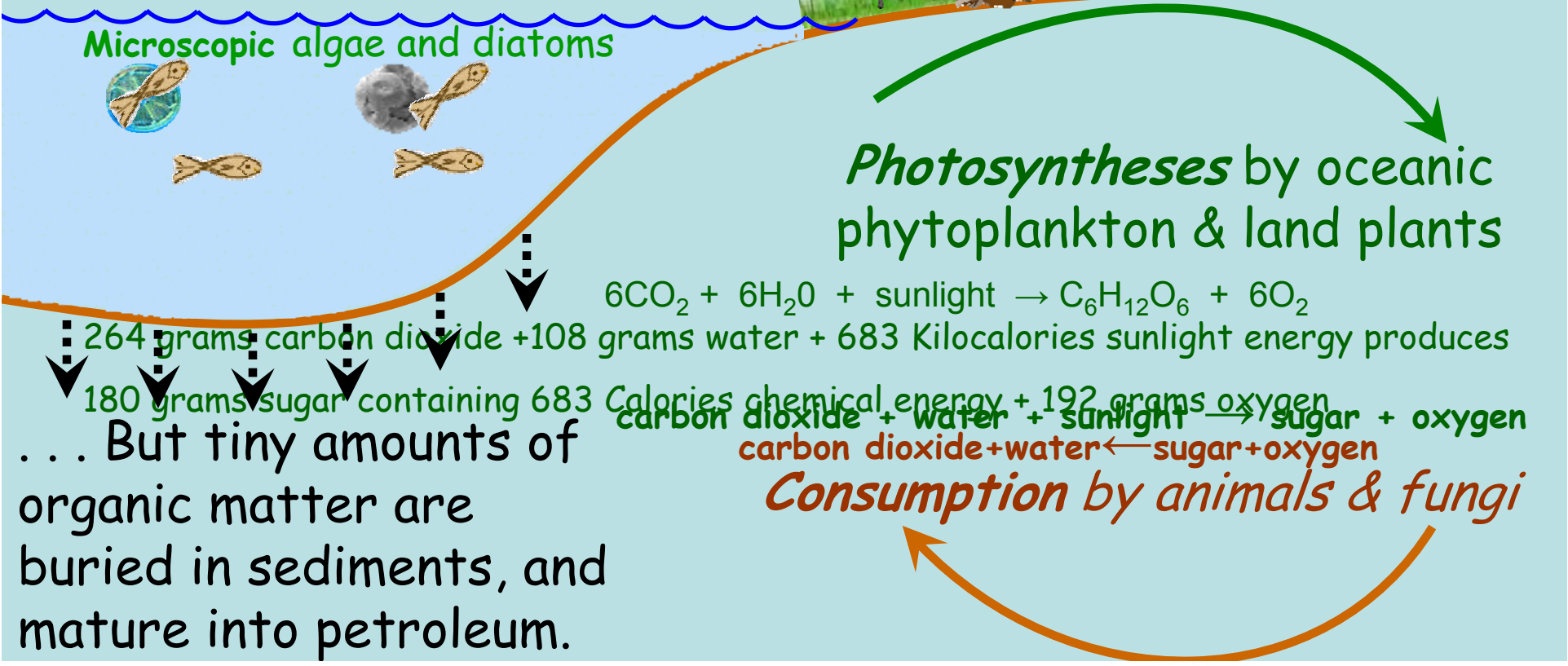
*Photosyntheses* by oceanic phytoplankton & land plants

$6\text{CO}_2 + 6\text{H}_2\text{O} + \text{sunlight} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$   
 264 grams carbon dioxide + 108 grams water + 683 Kilocalories sunlight energy produces

180 grams sugar containing 683 Calories chemical energy + 192 grams oxygen  
 $\text{carbon dioxide} + \text{water} + \text{sunlight} \rightarrow \text{sugar} + \text{oxygen}$

*Consumption by animals & fungi*

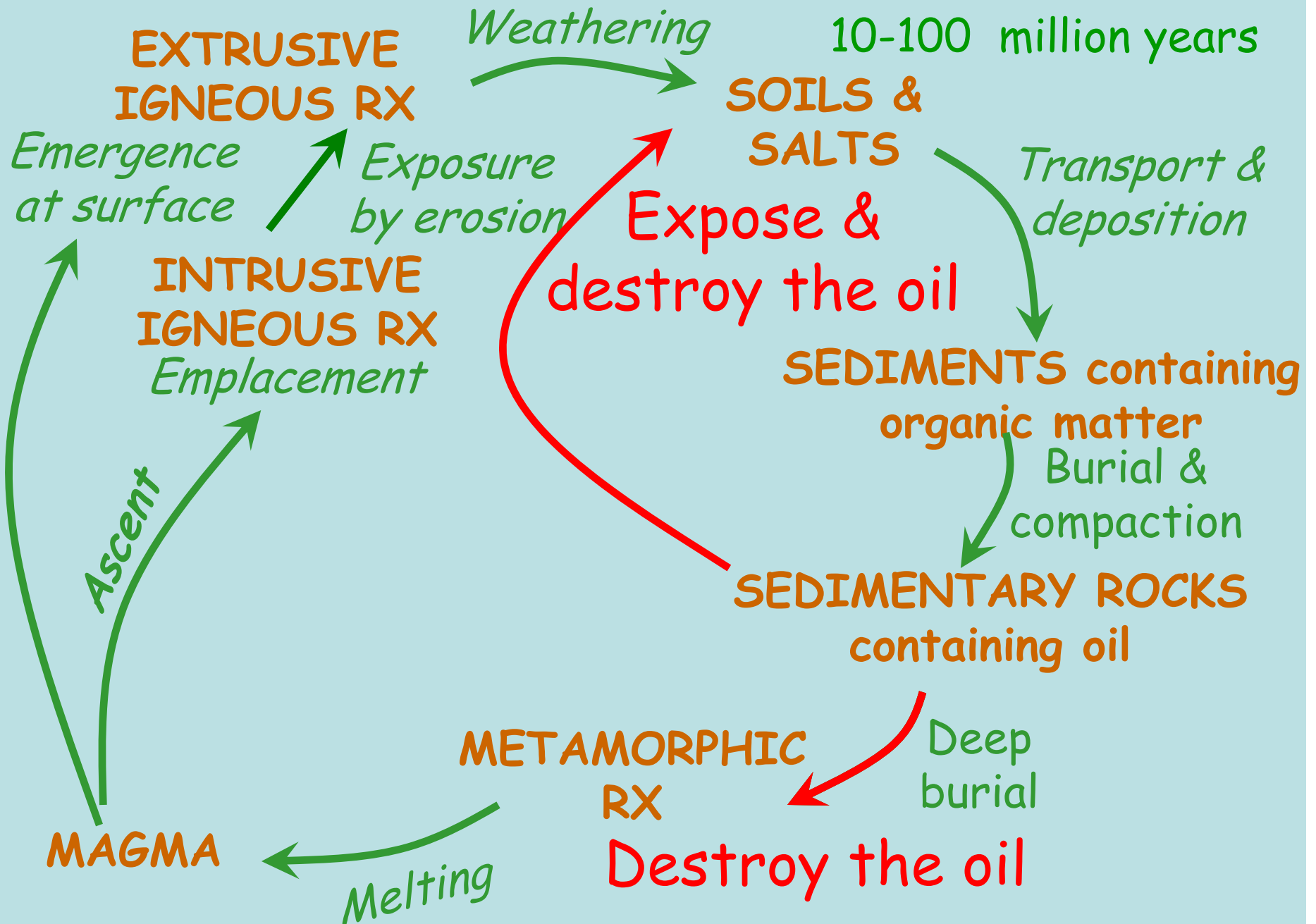
... But tiny amounts of organic matter are buried in sediments, and mature into petroleum.



# The Rock Cycle

# (Geologic Cycle)

10-100 million years



# Steady-state storage of oil:

Accumulation rate  $\approx$  Destruction rate

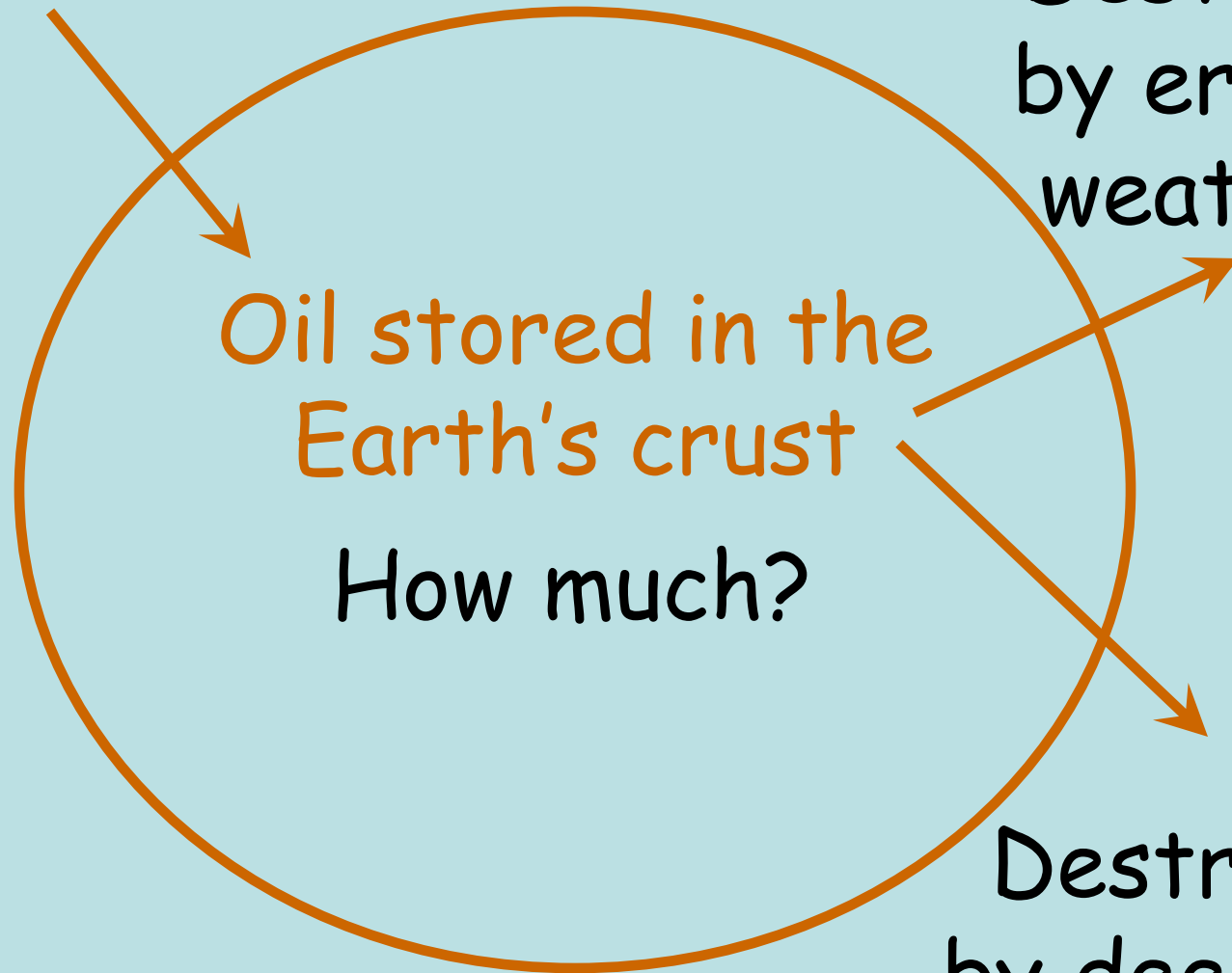
Accumulation

Destruction  
by erosion &  
weathering

Oil stored in the  
Earth's crust

How much?

Destruction  
by deep burial



## The best geological estimates:

1. How much oil had accumulated in the Earth before Humanity started using it?

Two trillion barrels (2,000,000,000,000)

2. How long did it take to accumulate?

Six hundred million years (600,000,000)

3. How much oil accumulated every average year?

$$\frac{2,000,000,000,000}{600,000,000} = \frac{20,000}{6} \approx 3,000 \text{ barrels per year}$$

Because this is so little, oil is essentially a  
*non-renewable resource!*

# Steady-state storage of oil:

Accumulation rate  $\approx$  Destruction rate

Accumulation:  
3,000 barrels/year

Destruction  
by erosion &  
weathering

Oil stored in the  
Earth's crust

3,000  
barrels/year

2,000,000,000,000  
barrels

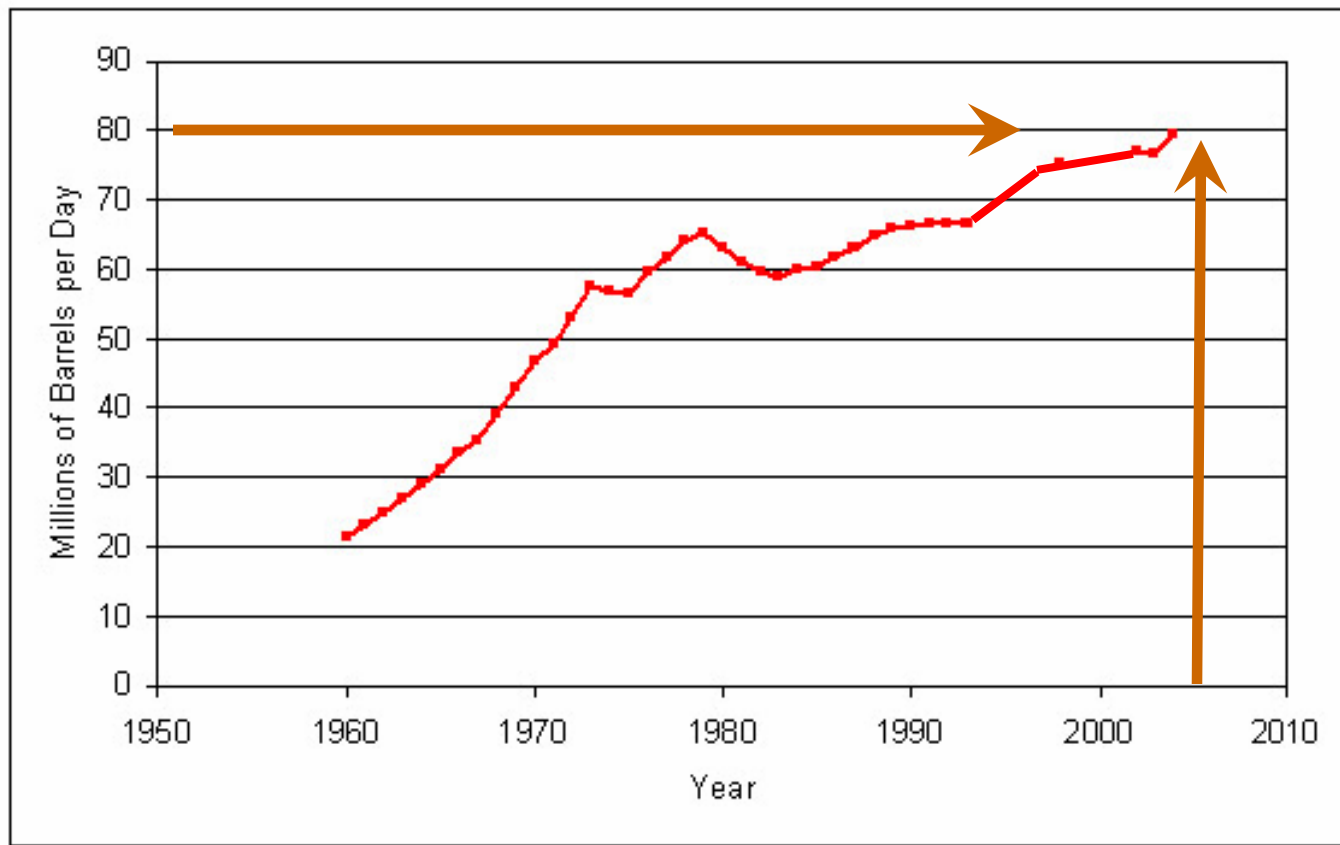
Destruction  
by deep burial

After many million years, a rough balance was attained between petroleum accumulation and destruction by deep burial and erosion.

At any time thereafter, about 2 trillion barrels remained stored in the rocks, an important factor in keeping atmospheric  $CO_2$  reasonably low . . .

. . .until we started extracting in in the 19<sup>th</sup> Century.

3,000 barrels accumulate in the Earth in one year . . .



All the people on Earth use 80 million barrels a day  
≈ 29 billion barrels each year.

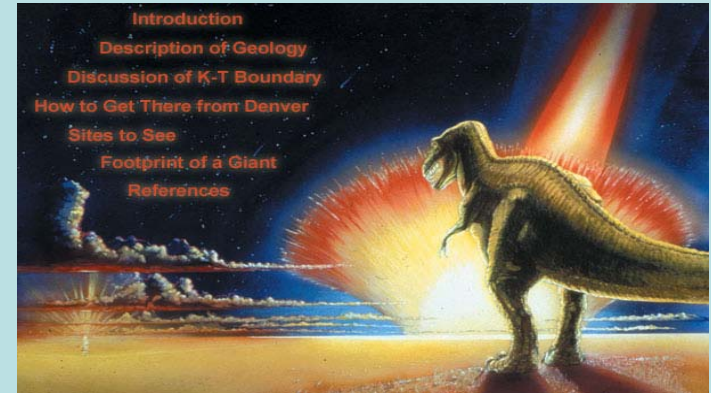
$$\frac{29 \text{ billion bbl}}{3,000 \text{ bbl/y}} \approx 8.8 \text{ million barrels/year}$$

What Humanity uses yearly took almost 9 million years to store.

In **one** year, Humanity pulls out of the rocks  
and burns, and returns to the air  
The carbon Earth took out of the air  
And stored in the rocks for almost  
**nine million years.**

Thus is Humanity inflicting on Earth's living environment  
one of the most severe abuses she has ever had to endure:  
The fever we call Anthropogenic Global Warming.  
Hurricanes Katrina, which drowned New Orleans,  
And Supertyphoon Mameng, whose lahars killed hundreds  
at Mayon Volcano in 2006  
May be but tiny symptoms of that trauma.

# Comparing two geological catastrophes



End-Cretaceous Chicxulub asteroid that wiped out the dinosaurs 65 million years ago: 10 km diameter, **13 billion tonnes**

## Anthropogenic fossil-fuel burning

A barrel of oil: volume = 159 liters

Specific gravity  $\approx 0.7$ , so mass of 1 barrel = 0.133 tonne.

1 trillion barrels of oil = **133 billion tonnes.**



We have also burned an equivalent mass of coal and natural gas

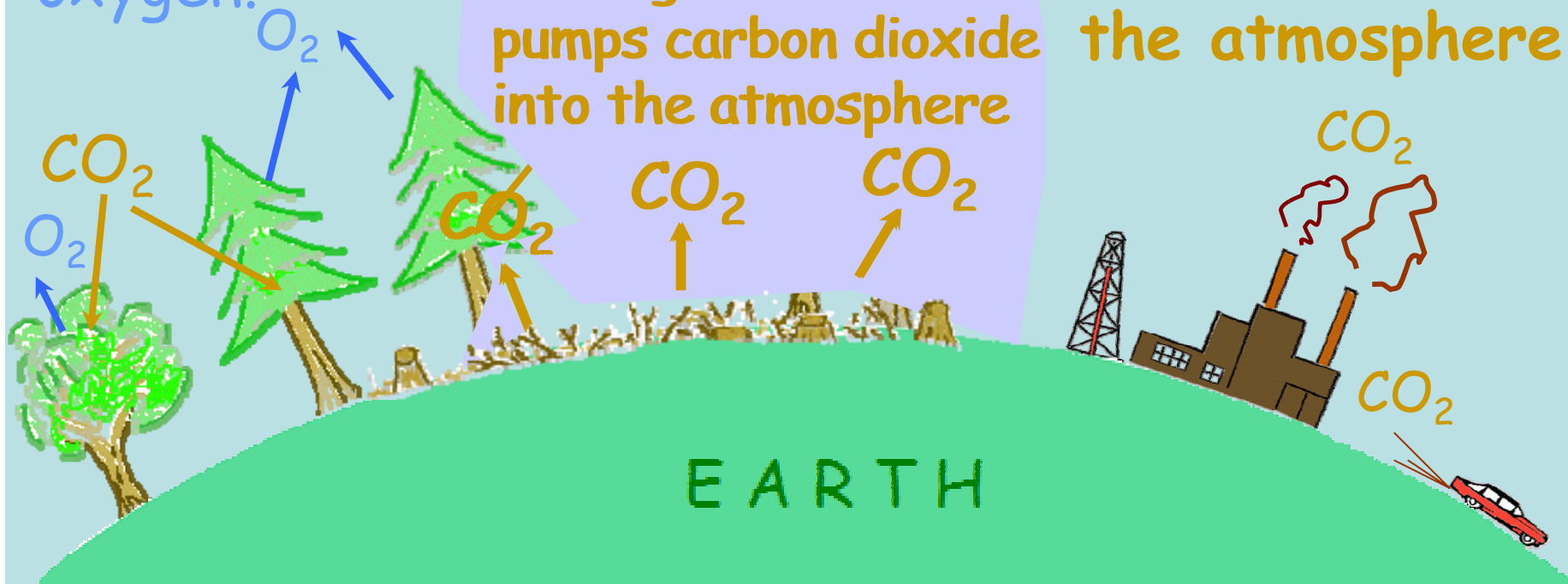
Global warming is due to human additions of carbon dioxide to the atmosphere.

### Deforestation:

1. Reduces removal of carbon dioxide from atmosphere
2. Rotting and burning tree debris pumps carbon dioxide into the atmosphere

Burning fossil fuels (oil, gas, coal) adds much carbon dioxide to the atmosphere

Trees absorb carbon dioxide, release oxygen.



# "Peak Oil" refers to the time

when HALF of all the oil in a single well, or an oil field, or a country, or the whole world, is used up.

After a discovery, production and use accelerate.

When peak production is reached, half of the oil has been used up.

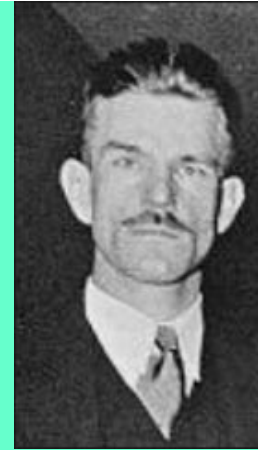
That first half is easiest to find and recover.

The remaining half is hardest to find, and most expensive to recover.

Some will **never** be recovered, because it would take more energy to extract than it can yield.

Following the **discovery** peak, development takes time, until **peak production** is reached.

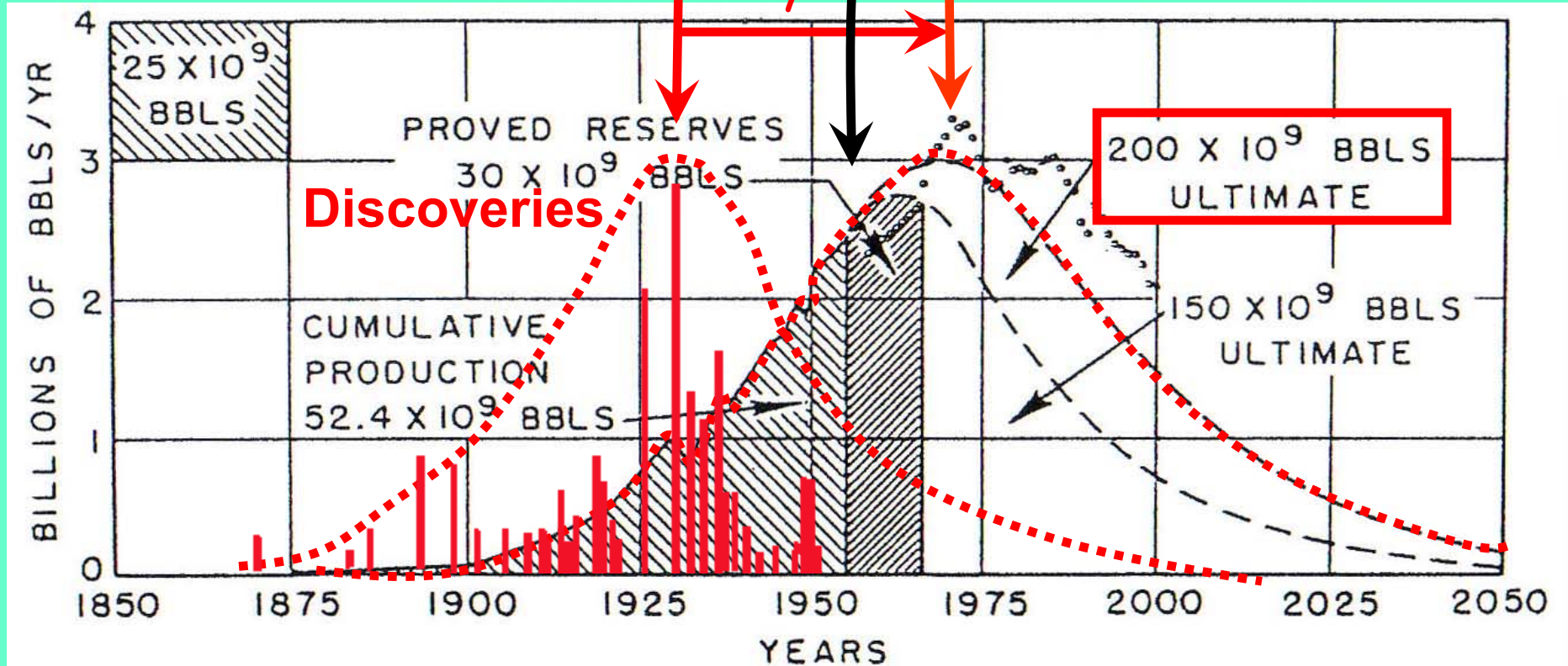
Global "Peak Oil" is when half of all the world's oil was used up. M. King Hubbert predicted Peak Oil for the U.S. in 1956.



Discovery  
peak 1930

Production  
peak 1970

40 years

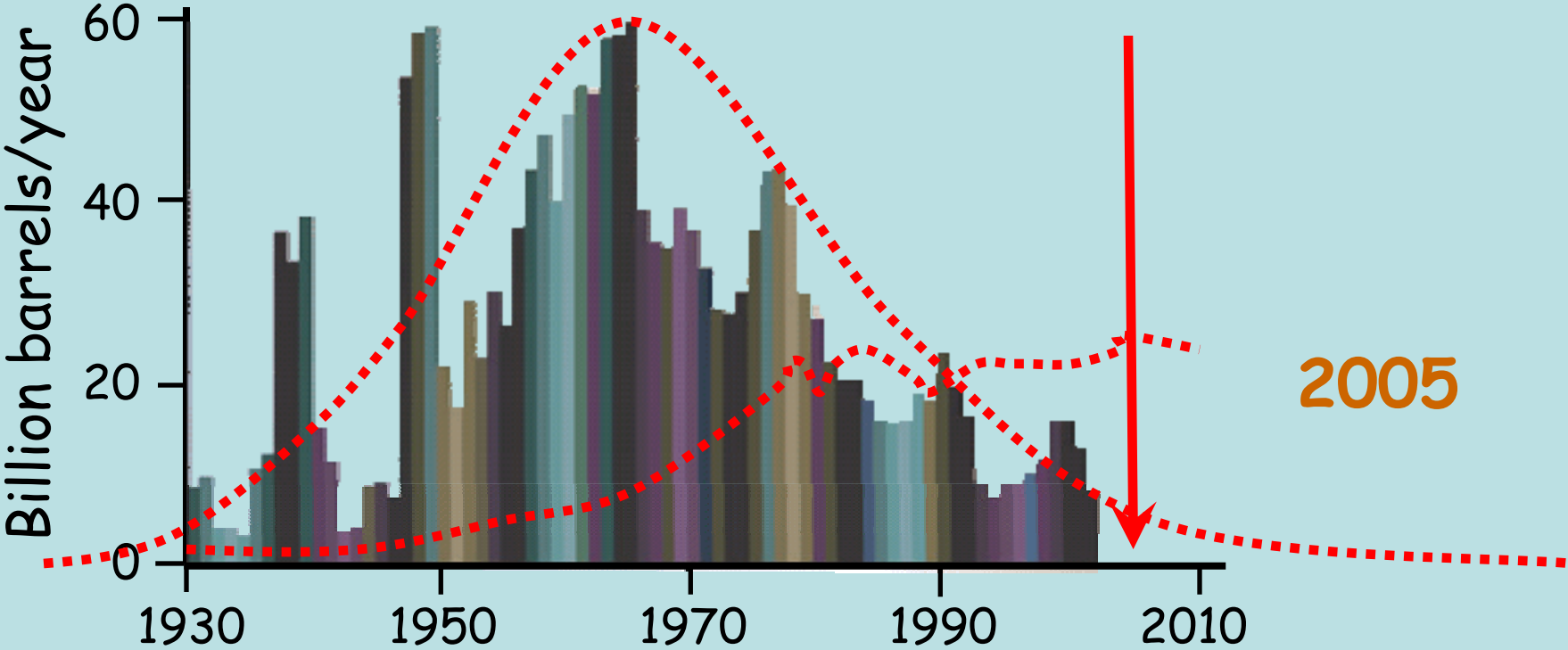


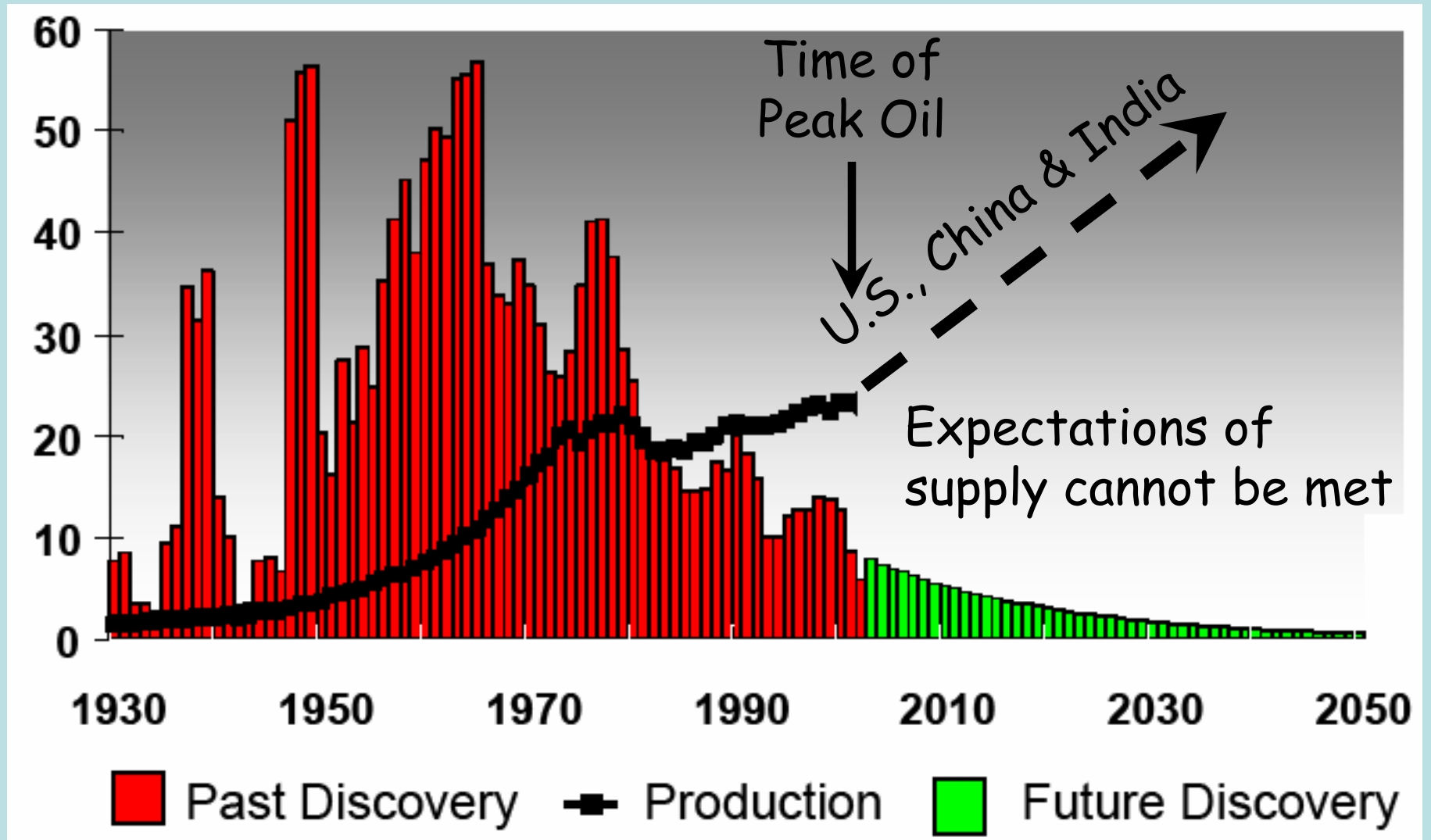
# Global Oil Peaks

Lag time: 40 years?

Discovery peak: 1965. Note the post-Peak decline, despite continued improvement in exploration technology

Production peak





Perhaps it is just as well that the crises of Peak Oil and Global Warming arrive together.

Both crises demand that we curtail our use of fossil fuels.

How much oil does the average American use every year?

The U.S. uses about 22 million barrels each day

$\times 365 \approx 8$  billion barrels each year

The U.S. population is almost 300 million Americans.

$\frac{8 \text{ billion bl per year}}{300 \text{ million people}} \approx 27$  barrels/American/year.

How much oil does the average Filipinos use every year?

Every day, the Philippines uses 338,000 bl  $\times 365$

$= 123,370,000$  bl each year

There are 84,620,000 Filipinos.

$\frac{123,370,000 \text{ barrels}}{84,620,000 \text{ people}} = 1.46$  barrels/Filipino/year

$\frac{27}{1.46} = 15.6$ . One American uses what more than 15 Filipinos use

The addiction to oil is much stronger in the U.S. than in the Philippines.

Two implications:

1. The true addict will do whatever it takes to get her or his "fix" -- will even kill if necessary.

That is the real reason behind the U.S. invasion and occupation of Iraq, and its tensions with Iran and Venezuela.

2. By the grace of God, the Philippines can wean itself from oil much more easily.

Diyos ti agngina,  
Dakal pung salamat,  
Daghan kaayong salamat,  
Marami pong salamat  
sa inyong lahat  
Thanks, y'all