

Rock Cycle Part II Student Guide

Drawing the Complete Rock Cycle

According to your Rock Cycle Part I diagram, sedimentary rock must go through the five processes of metamorphism, melting, crystallization, sedimentation and lithification before it becomes sedimentary rock again. In reality, there are several “shortcuts” in the cycle. Depending on the forces to which sedimentary rock is subjected, it may become metamorphic or it may go straight to magma. It may also weather and return to its sediment state. Igneous rock can melt to become magma and it can change into metamorphic rock. Metamorphic rock can weather and erode to become sediment.

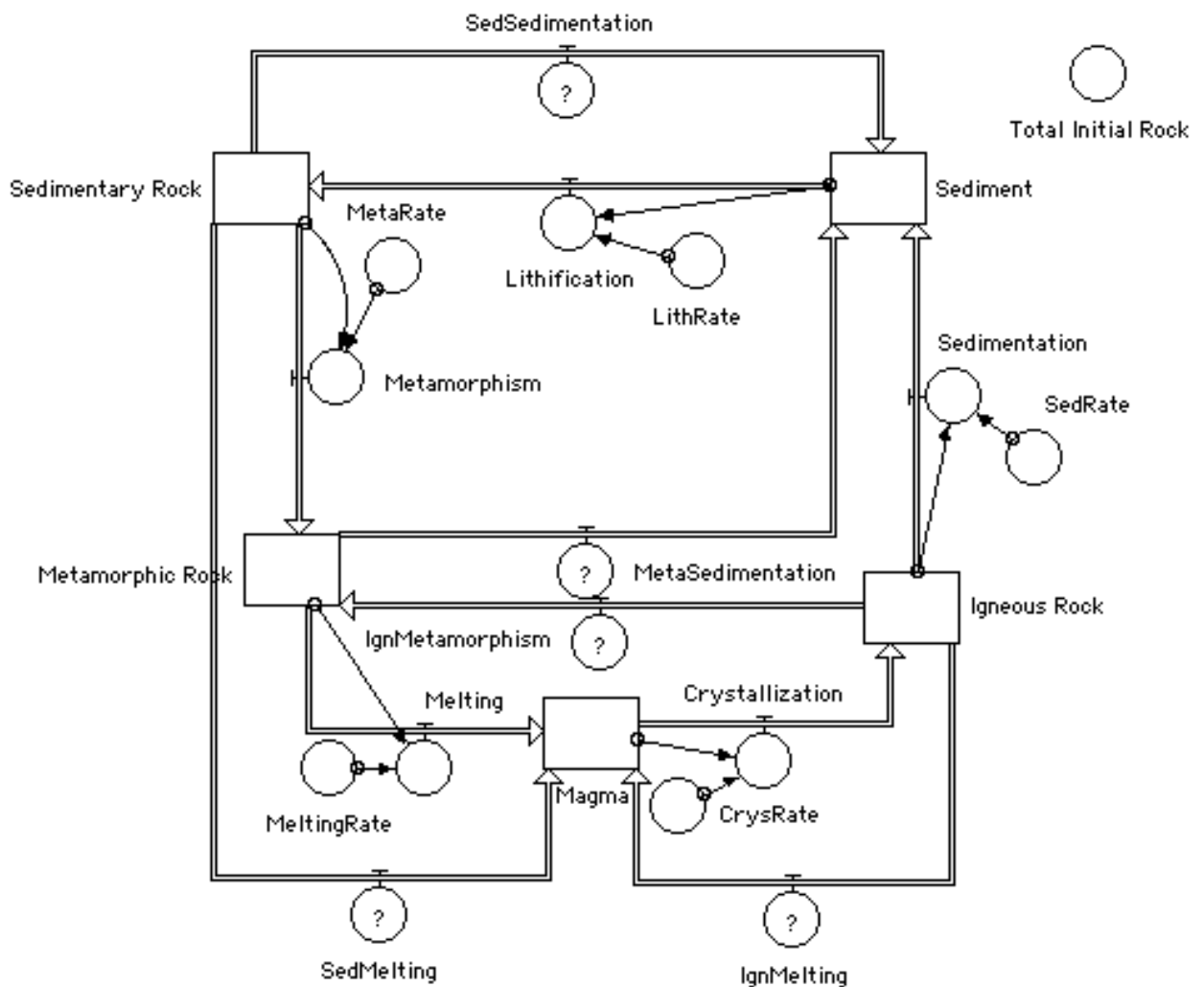
In the space below, draw the complete rock cycle.

Building the Complete Rock Cycle Model

Open the Simplified Rock Cycle Model. You will now add five flows to your STELLA model to make it complete.

Flow Name	From	To
SedMelting	Sedimentary Rock	Magma
SedSedimentation	Sedimentary Rock	Sediment
IgnMelting	Igneous Rock	Magma
IgnMetamorphism	Igneous Rock	Metamorphic Rock
MetaSedimentation	Metamorphic Rock	Sediment

The diagram below shows the rock cycle model with 5 flows added.

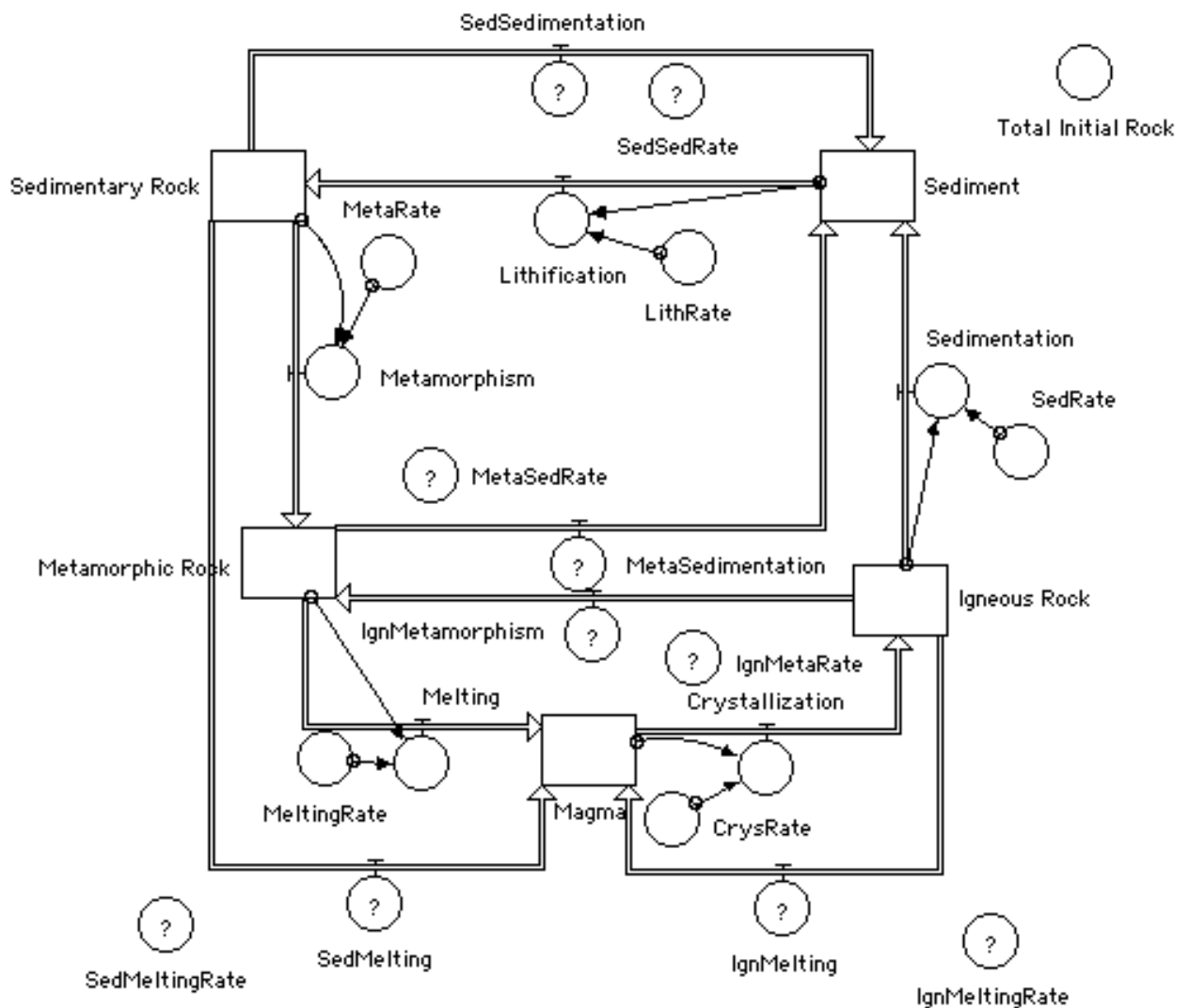


Adding the converters

As with the simplified rock cycle, you will now add five converters which will hold the fractions that represent how quickly one type of rock transforms into another. Place each converter near its associated flow.

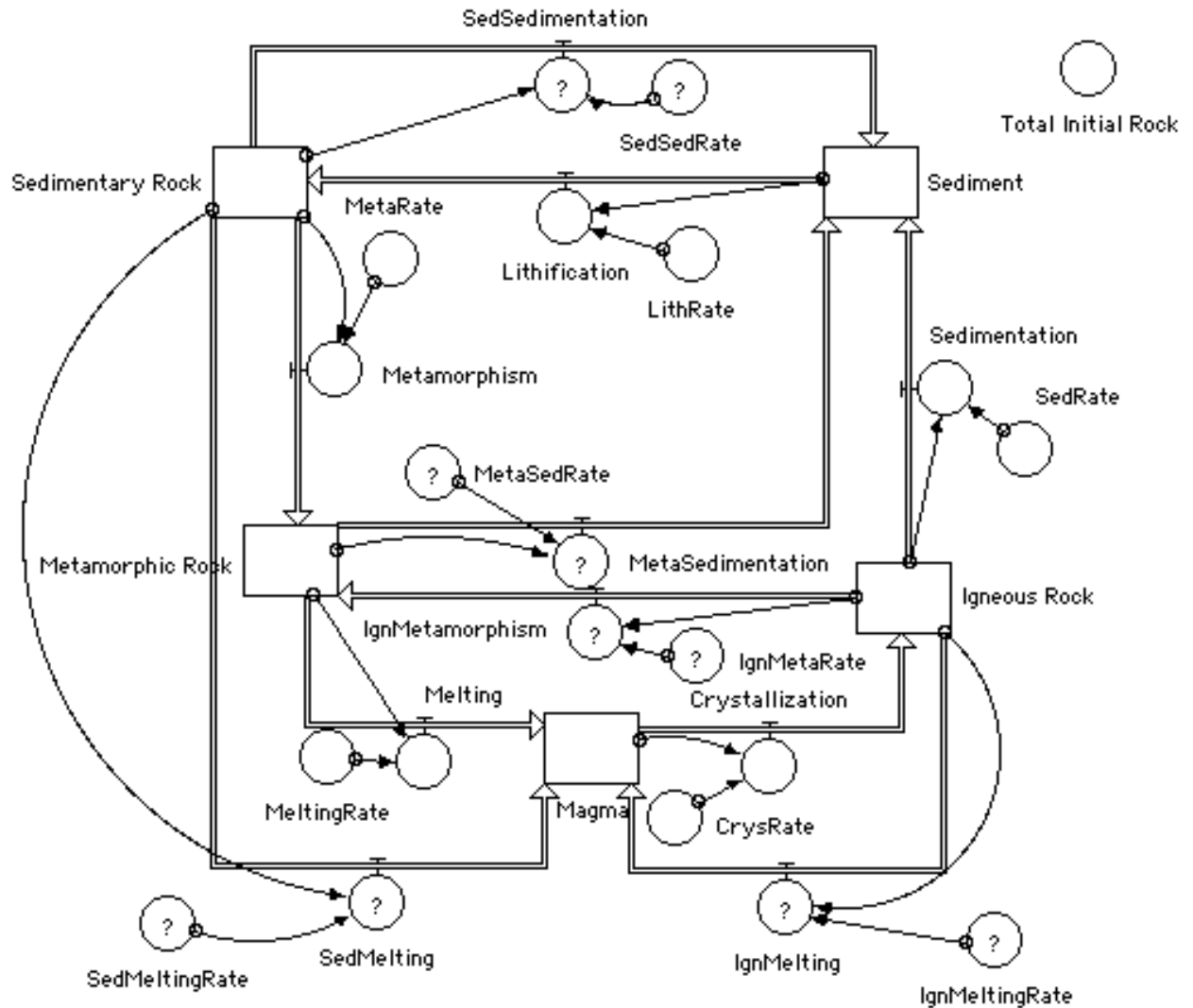
Converter Name	Associated Flow
SedSedRate	SedSedimentation
MetaSedRate	MetaSedimentation
IgnMetaRate	IgnMetamorphism
SedMeltingRate	SedMelting
IgnMeltingRate	IgnMelting

The diagram below shows the rock cycle model with the 5 converters added.



Adding the connectors

You will now add ten connectors to complete your diagram. Each new flow should have two connectors coming to it. Use the diagram as a guide.



Entering values for the converters

Double-click on each converter with a question mark and enter the fraction listed below. Then click OK.


SedSedRate: 1/12
MetaSedRate: 1/12
IgnMetaRate: 1/18
SedMeltingRate: 1/12
IgnMeltingRate: 1/17

Entering formulas for the flows

Double-click on each flow with a question mark. In the window that appears, notice the box titled Required Inputs. To enter the appropriate formula from the list below, click once on each word in the Required Inputs box and place a multiplication symbol * between the words. You may also type out the formula in its entirety, but beware of spelling mistakes.

Flow Name	Formula
SedSedimentation:	Sedimentary_Rock*SedSedRate
SedMelting:	Sedimentary_Rock*SedMeltingRate
IgnMelting:	Igneous_Rock*IgnMeltingRate
IgnMetamorphism:	Igneous_Rock*IgnMetaRate
MetaSedimentation:	Metamorphic_Rock*MetaSedRate

Coloring the Complete Rock Cycle Model

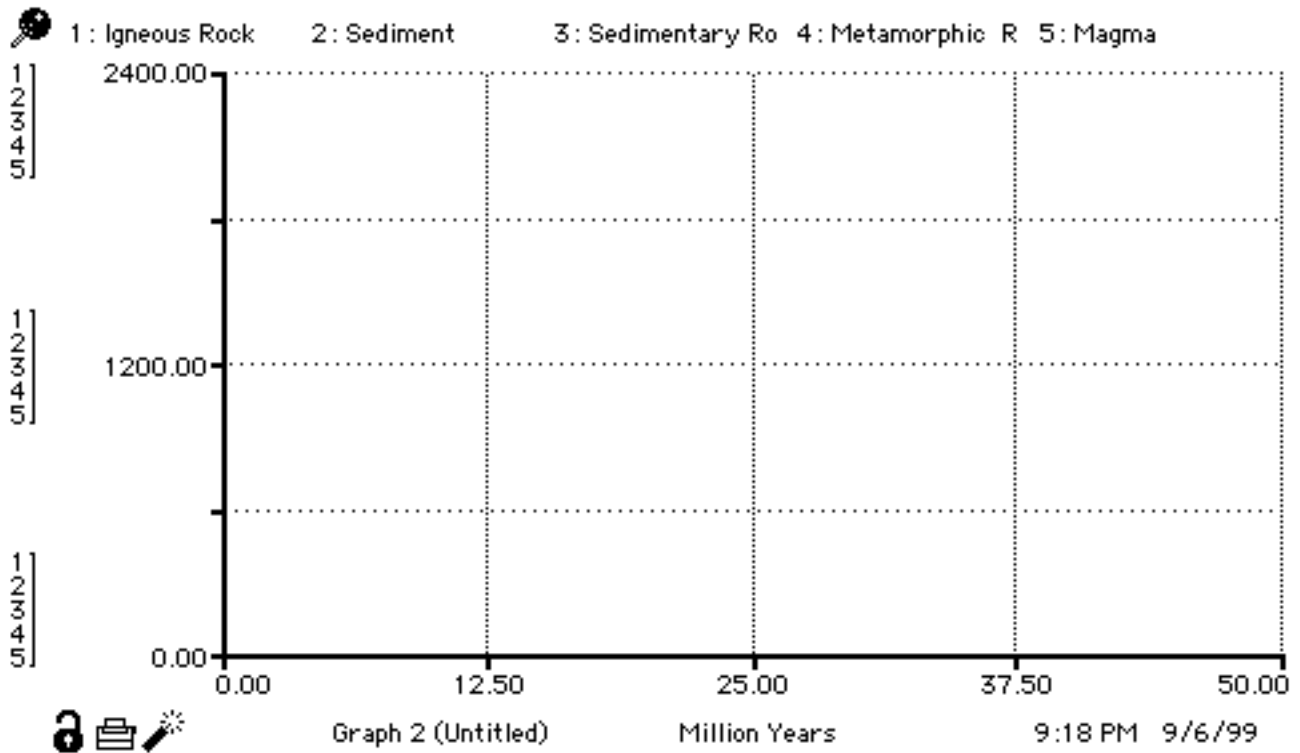
- Hold down the paintbrush  icon in the tool bar and choose a color.
- Click on a stock to turn it the color you chose.
- Make the outflows from the stock the same color as the stock.
- Color each stock a different color, making the outflows the same color as the stock.

Rock Cycle Part II Student Answers

Scenario 1: The Rock Cycle in Equilibrium

Choose Run from the RUN Menu at the very top of the model. Double-click on the graph icon to re-open the graph. Examine the graph carefully. The model ran for a period of 50 million years (the **x-axis** of the graph). The y-axis of the graph is displaying the **amounts** of the different rock types for this period. The units for the y-axis are in grams * 10^{24} . For example, 1200 means $1200 * 10^{24}$ grams of rock.

Q1. Referring to the Level I Generic Graph Questions, sketch the graph on the axes provided. (Do not forget to label your lines/curves.)



Q2. What does the graph show about the different types of rock for the given time period?

Q3. What is the term used to describe this state or condition?

Scenario 2: Simulating a decrease in Tectonic Activity on Earth

Close the graph so you can view the model.

Double-click on the **MetaRate** Converter and decrease it from 1/12 to 1/24.

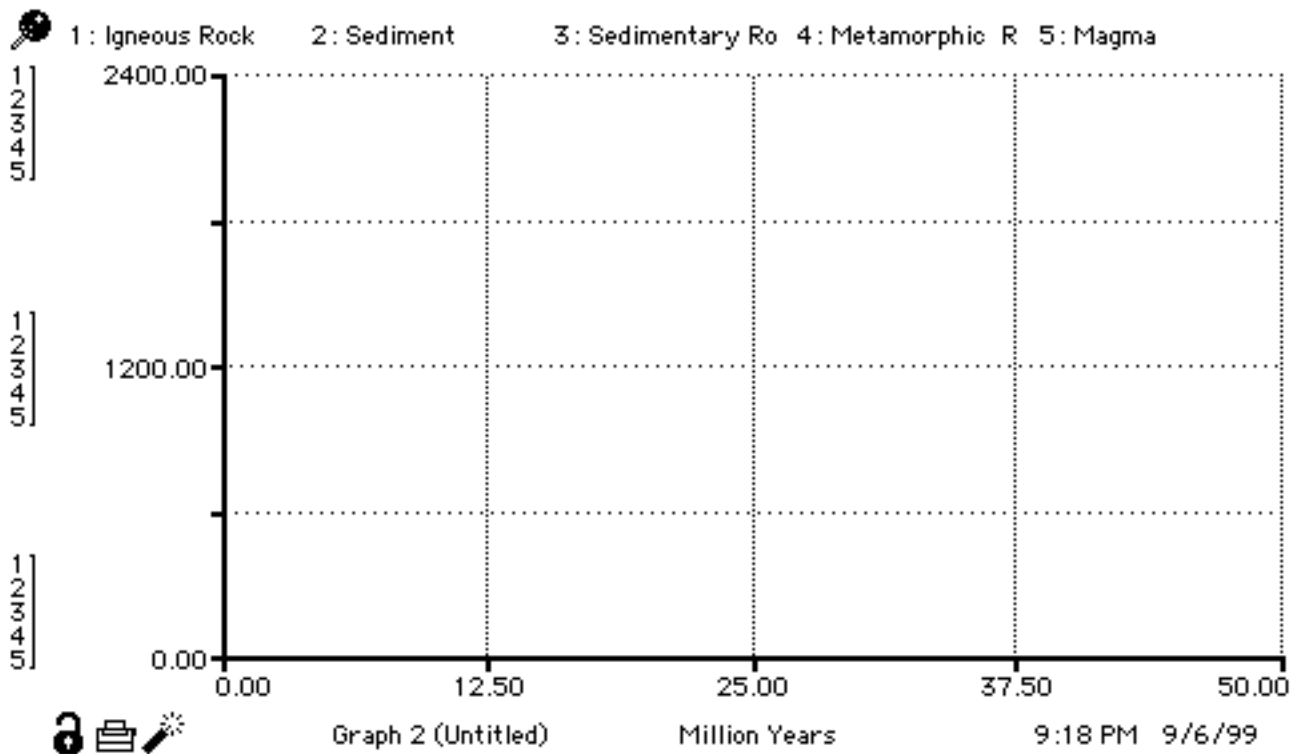
Q4. Which stock is drained by the Metamorphism process?

Q5. Which stock is filled by the Metamorphism process?

Q6. What effect do you expect the decreased rate of Metamorphism to have on these two stocks?

Run the model and open the graph.

Q7. Referring to the Level I Generic Graph Questions, sketch the graph on the axes provided.
(Do not forget to label your lines/curves.)



Use the graph to answer the following questions.

Q8. Referring to the Generic Graph Guidelines, describe in full the curves on the graph.

Q9. Explain why the sedimentary rock stock increased to a new equilibrium when the MetaRate decreased in value.

Q10. Explain why the metamorphic rock stock decreased to a new equilibrium when the MetaRate decreased in value.

Scenario 3: Simulate an increase in Volcanic Activity

Close the graph so you can view the model.

Double-click on the **MetaRate** converter and set it back to 1/12.

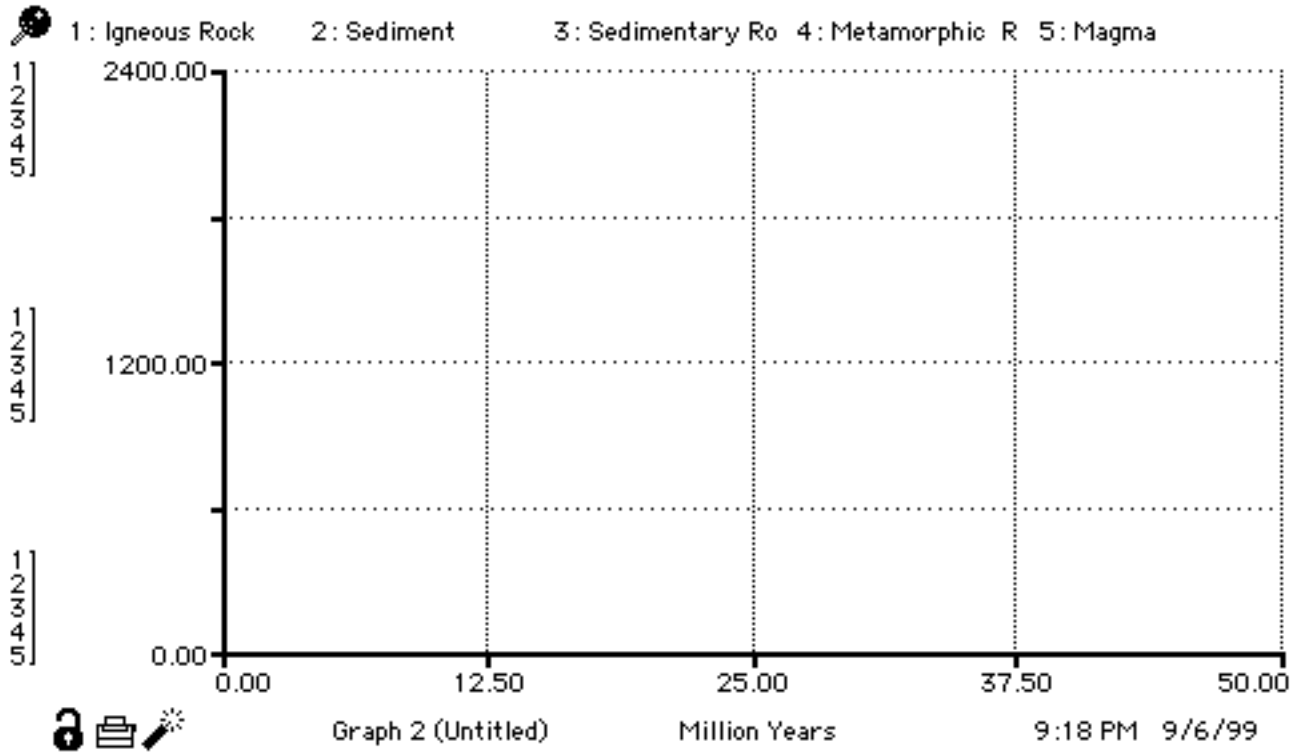
Double-click on the **MeltingRate** converter and increase it from 1/13 to 1/10.

Double-click on the **SedMeltingRate** converter and increase it from 1/12 to 1/8.

Q11. Before running the model, predict what will happen to the amounts of igneous rock, magma, metamorphic rock, sedimentary rock and sediment with increased volcanic activity.

Run the model and open the graph.

Q12. Referring to the Level I Generic Graph Questions, sketch the graph on the axes provided. (Do not forget to label your lines/curves.)



Q13. Compared to your graph from Scenario 1, which stocks are affected by this change and how do they change?

Q14. Does the rock cycle come to a new equilibrium? How is it altered?

Scenario 4: A Deeper Look at Equilibrium

Close the graph so you can view the model.

Double-click on the **MeltingRate** converter and set it back to 1/13.

Double-click on the **SedMeltingRate** converter and set it back to 1/12.

Run the model. Open the graph. You should see five horizontal lines.


Let's look at the equilibrium of Metamorphic Rock.

Q15. What are the inflows of Metamorphic Rock?

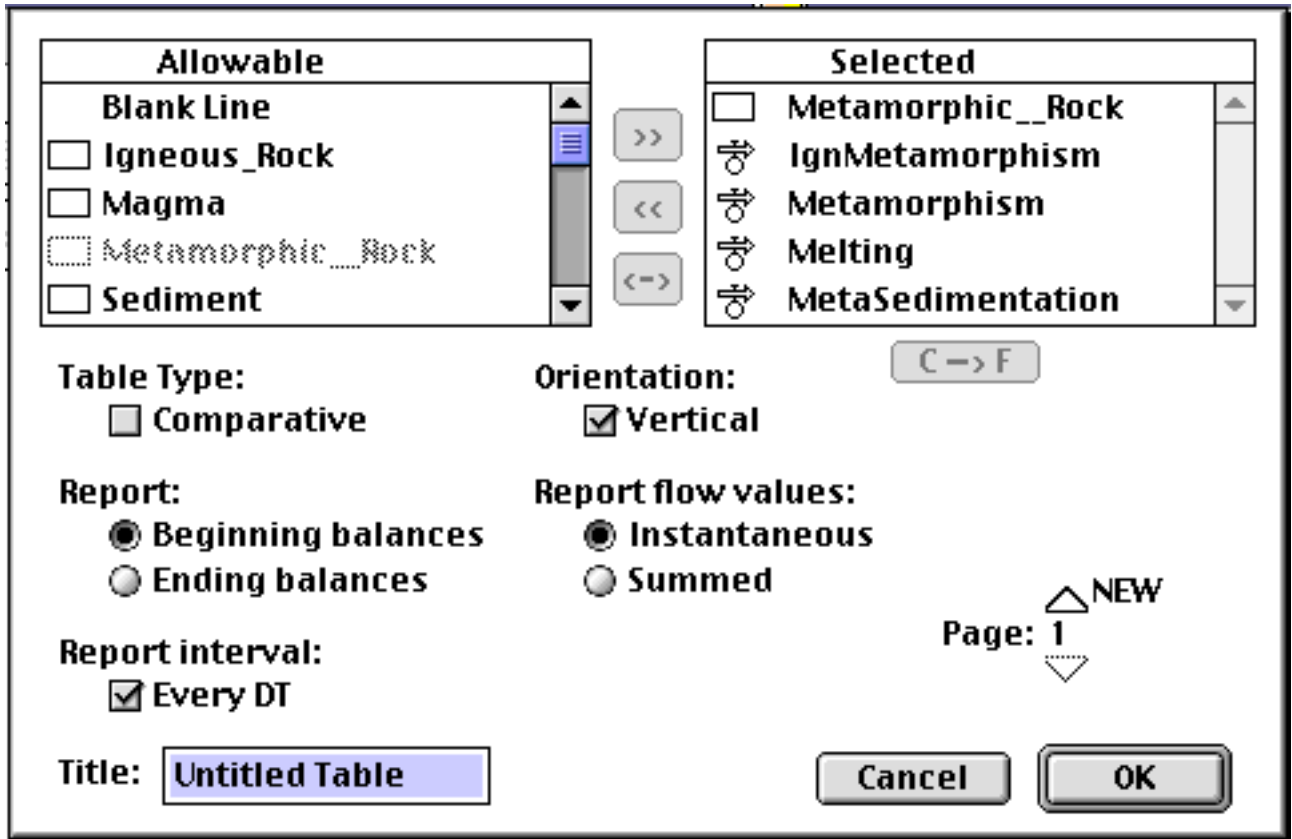
Q16. What are the outflows of Metamorphic Rock?

In order to look at the values of these inflows and outflows we need to set up a table.

Setting up a Table of Values:

- Click on the table icon  in the toolbar and place the icon in an open space around your model.
- Double-click on the blank table.
- Double-click on Metamorphic_Rock in the Allowable box to move it to the Selected box.
- Scroll down in the Allowable box until you come to the flows.
- Double-click on each of the inflows and outflows you listed in Q15 and Q16 so that they move to the Selected box.

Your window should now look like the one on the next page:



Click on OK and run the model.

Notice that the values in each column end up being constant.

Q17. What do the last inflow values add up to?

Q18. What do the last outflow values add up to?

Q19. How does this show that Metamorphic Rock has reached equilibrium?

Q20. Demonstrate the concept of equilibrium for a rock type other than Metamorphic by showing that the total inflow equals the total outflow.

Extension: A cooling Earth

Suppose that the Earth started to cool. Since heat is necessary for several of the processes in the rock cycle, the absence of heat would certainly alter the cycle. Would the Earth become like the Moon, solid rock with a thin film of sediment? Make appropriate adjustments in your model to simulate the effect of a cooling planet.

Q21. Referring to the Level I Generic Graph Questions, sketch the graph on the axes provided. Also, describe your scenario in the space provided.

