**Transcript of MCS v.2019 RnFC Run MES Input File YouTube Video**

**0:00**

In this video, I’m going to walk you through how to prepare an input file for a recharge and fractional crystallization run using the Magma Chamber Simulator. So the first thing we need to do is open up our input file. In order to get to that, we need to navigate to our Finder Window. Once there, get to our Documents folder, open up the MCS folder structure, and then open up the “Input & Output” folder. Again, if you’re making your own input file from scratch, you can use the general “Prototype MES” file we’ve provided. But for right now, we’re going to open up our pre-populated file, and that’s “MES\_RFC\_1” (my apologies).

**0:48**

And the first part of the MES file we need to complete is this blue box – remember from last time we set our global system variables here. Uh, so we’re not assimilating the wallrock in this run, so we can go ahead and set our fmZero to 1. We’re also not excluding any phases, so we can leave that blank. And we want to run this model at about 2 kilobar pressure, so we’ll enter 2000 bars in that cell. Let’s leave Enthalpy Convergence Steps alone – remember, the sweet spot for this variable is 30, so leave 30 in this box unless you find yourself with an unreasonably good reason to. For our final global system variable, oxygen fugacity, we don’t want to run along a buffer during this simulation. So we need to type in “none” – remember, exactly as given in Column F – into this cell.

**1:40**

For our Magma subsystem, we’ve pre-populated this MES file with a basaltic composition, and we’ve renormalized to 100 wt.%. So we can set our Magma subsystem starting temperature at 1300 degrees – remember, this is just a jumping-off point for MELTS to find the liquidus temperature for the Magma composition, so it doesn’t really need to be particularly above or below the liquidus temperature, just somewhere in the general vicinity of that number. We’re also going to lower our deltaT from the FC-only tutorial; and so now each equilibration step will occur every time the Magma subsystem has cooled 5 degrees. I wouldn’t really advise going any lower than that – the lowest I’ve been able to run without an issue is a deltaT of 2 degrees, but the MCS was REALLY sluggish and unhappy due to the intensive nature of the calculations required. Finally, we have our two different options for stopping the MCS runs prematurely – either a Hard Stop Temperature, or at a certain percentage of liquid left in the Magma subsystem. We’re going to go ahead and employ the Hard Stop Temperature function, and let’s set it to 950 degrees.

**2:56**

For our Wallrock composition, we have a really nice Sierra Nevada Granite – and again, it’s had some water and some CO2 added to it, and it’s been renormalized to 100 wt.% as well. As a reminder, because there is CO2 in all three of these compositions, I’m going to want to run this model in either r-MELTS 1.1.0 or 1.2.0, because those are the ones that can model CO2… uh… if you put them in the Input File. We don’t need to do anything else with the Wallrock parameters for now, as we’re not assimilating anything in this run, so let’s continue on down the MES file.

**3:35**

So the first thing you need to consider when you are running a magma mixing model (uh, the Recharge function of the Magma Chamber Simulator is a mixing and hybridization step, so please forgive me if I use mixing and recharge interchangeably) uh, but that’s how you want the Recharge to be triggered during your simulation. We can use the “Recharge Trigger Mode” option to tell the MCS whether we want our Recharge Events to be triggered by choosing a specific temperature for the Magma Subsystem (uh… by using either the “byTemp” or “byTempSerial” functions) at which the mixing event will occur, or by specifying that you want Recharge to occur after the Magma Subsystem has undergone some degree of cooling (and this is the “byDelta” function). This is a one-or-the-other sort of situation – so you can either have all of your recharge events triggered “byTemp”, or “byDelta”, but not both, so whatever you set – stick with it. We’re going to go through all three types of Recharge triggering in this tutorial, so let’s start with the “byTemp” method of triggering a Recharge event first. In order to enable this function, we need to make sure that cell B63 says “byTemp”, and remember – capitalization *counts*.

**4:51**

So let’s scroll on down to our first Recharge composition. Now, I’ve just put in another general basaltic – I think this might be a Hawaiian composition, but I’m not quite sure) – it’s not too hydrous, throw a little bit of CO2 for good luck. And the temperatures and masses for each Recharge event are below each Recharge event’s composition – let’s scroll down and we can take a look. Here at Recharge Event number 2, we have our composition first, and below we have our mass and temperature parameters are located below it; the other three Recharge Event variables are organized in the same manner.

**5:35**

Okay, we can scroll back up to Recharge Event 1 and set its parameters. The first parameter we want to set is the “Recharge1Mass”. Like the Wallrock Subsystem, the Recharge Subsystem can be any mass (we are not restricted to 100g, as we are in the Magma Subsystem). So, let’s put in 20g. The next parameter, “Recharge1Temperature” is the temperature the Recharge magma *actually is at* when the recharge event is triggered. So for this model, we want the temperature of the Recharge Magma to be 1150 degrees, which we’ll enter here. The third parameter, “Recharge1TriggerTemperature” refers to the temperature of the Magma Subsystem at the time of recharge, or *when* (but in temperature, because the MCS really doesn’t have a temporal component) you want the recharge event to occur. We want the first recharge event to occur when the Magma Subsystem has cooled to a temperature of 1000 degrees, so let’s enter that in cell B89. The last parameter is the “Recharge1DeltaTriggerTemperature”, and unless you are using the “byDelta” recharge triggering mechanism, you’re going to want to leave this blank. We’re going to come back to the “byDelta” recharge shortly.

**6:57**

Now, for this particular model, I need two different recharge events to be triggered, so we’re going to fill out information for the second recharge event as well. I’ve used the same Recharge composition as before, but this time we want to mix in 25g of our basalt when it is 1125 degrees, and our Magma Subsystem is 1150 degrees. So, let’s enter 25g in for “Recharge2Mass”, 1125 in for the temperature of the recharge magma, and 1150 for the temperature that the recharge will occur at, and again, we’re going to make sure to leave that last cell blank. We can also scroll down through the rest of the Recharge events – *just* in case – to make sure that the masses are set at 0, and there’s no trigger temperature set (I just like to be safe…).

**7:57**

And that’s it! So we’ve completed the MES file for an RFC run where recharge is triggered by setting a particular temperature. We can save our MES file, but I want to keep it open, because we’re actually going to do the same model, but employing the “byTempSerial” function. So, let’s save this file as “MES\_RFC\_2.xlsx” (I already have it here, but I’ll go through the motions…), and that gets saved again in the Input & Output folder structure. After we’ve saved the file, we can go back down to row 63, and we want to change our Recharge Trigger Model from “byTemp” to “byTempSerial” – again, spelling & capitalization counts - and then save the file again.

**9:06**

So, here’s the difference. Take a look at the trigger temperatures we’ve set for Recharge Events 1 and 2 a little bit closer – and you should see that the recharge temperature for Recharge Event 1 – I’m sorry, the *trigger* temperature for Recharge Event 1 - is actually *lower* than that of Recharge Event 2. This is where the “byTemp” and “byTempSerial” distinction arises – so, if recharge is triggered “byTempSerial”, the Recharge Events will proceed in the order they come (so, Recharge 1 comes before Recharge 2 comes before Recharge 3, etc., etc.). *BUT*, if recharge is triggered “byTemp”, as we did here er… I’m sorry, as we did in the first one, uh, the Recharge Events will be triggered in decreasing order of their set trigger temperatures. So in the case of MES\_RFC\_1.xlsx, Recharge Event 2 *should* have been triggered *before* Recharge Event 1. And we can see if this really is the case by comparing the Output Files for both of these runs.

**10:10**

Alright, now I’ve gone ahead and done these runs ahead of time, but once they’re side-by-side, we don’t even really need to zoom in here for you to immediately notice the difference! So let’s zoom into the RFC\_byTemp one so we can actually see what’s going on…. Uh, Recharge 2 was set to occur when the temperature of the Magma Subsystem was 1150, and as soon as it dipped below that, our recharge event was triggered. We can tell it occurred because the MeltsRunMode – over here in Column B - has changed from “MagmaEquilibrateB” to “RechargeEquilibrate”, and the two rows which calculate the recharge event are highlighted in orange. The first of these orange rows gives us the state of the… of the Recharge *at the time* ***of*** *recharge*, you know, *pre-*hybridization, immediately before the magmas mix together – what is the state of the recharge system? And that’s the information that’s recorded in this line.

**11:17**

The second row, “MagmaEquilibrateC”, gives us the new, equilibrated state of the *now-hybridized* system – uh, and remember, just as with the AFC, there’s no fractionation going on yet. So, over here we would have new minerals in our magma! And, we have a new Magma liquid composition that’s a little bit more mafic than before, which is what we would expect by adding a little basalt in. And after the orange step happens, we go back to fractional crystallization. We can see that, because we’re back to “MagmaEquilibrateB”. Further on down, we can see that Recharge 1 was triggered when the Magma cooled to just below 1000 degrees. So, it was triggered when the Magma reached 999.74 degrees. So, when you do RFC “byTemp”, it really doesn’t matter at all what order you put your Recharge Events in. Uh… they will be triggered according to temperature.

**12:24**

On the other hand, using the “byTempSerial” function will cause Recharge 1 to occur first, regardless of the conditions you’ve set for the remaining Recharge events. So, see how we have no recharge occurring until the Magma Subsystem cools to 1000 degrees? (I’ll zoom in, because obviously *nobody* can see that.) So, once our Magma Subsystem cools to 1000 degrees, the first Recharge Event is triggered. And, because Recharge 2 has a trigger temperature that’s actually higher than the temperature of the new hybridized magma composition (which, right here is 1073 degrees, which is less than the 1150 we set it to trigger Recharge 2 for), so its going to get triggered immediately after Recharge 1. Moral of the story is, if you’re running a RFC or a RAFC model and you’re using the “byTempSerial” trigger function, the Recharge Events will always occur in the order they appear on the MES Input File.

**13:33**

For the final trigger method, “byDelta”, we’re going to do an RAFC run (so Recharge + Assimilation + Fractional Crystallization in one fell swoop), and we’re going to trigger the recharge events to occur after, you know, some degree of cooling – you’ll see what I mean in just a second. Let’s open up our pre-populated file, MES\_RAFC\_3.xlsx. And next let’s scroll down, again, to row 63, and we want to make sure that this says “byDelta”. Down here at the bottom of Recharge Event number 1, we can see that we need to put in some number here. And whatever number we put in, after the Magma Subsystem has cooled that number of degrees, a Recharge event is going to be triggered. Now, each Recharge event can have its own deltaT to be triggered at, *and* like in the “byTempSerial” trigger method, Recharge 1 will occur before Recharge 2, which will occur before Recharge 3, and so on and so forth. So let’s put 100 here in cell B90, and we want to make sure and delete the Trigger Temperature we’ve set before (it’s already gone). It’s not necessary to have that blank, but it does keep things cleaner. So essentially what will happen here is that the Magma Subsystem will cool 100 degrees from its liquidus, at which time Recharge 1 will be triggered.

**15:20**

We can scroll down, and let’s do the same thing for Recharge Event number 2, but we’re going to have it triggered after, say, another 50 degrees of crystallization. So, if you’d like to run this model yourself, go ahead and save this file to your Input & Output Folder. Uh, in the meantime, I’m going to open up the Output File for this run.

**15:46**

And we can see what the data generated by using the “byDelta” trigger function looks like. So we can see that just as before, the RFC calculations are in the orange rows, and the AFC calculations are in the cyan rows (let me zoom in… okay). The temperature of the Magma Subsystem is given in Column D, and we can see that Recharge 1 is indeed triggered after the Magma has cooled 100 degrees. After the first recharge event, we have our new hybrid magma state, and we can see that the Magma temperature has gone up - just a smidge – but that’s expected considering the high temperature of the Magma, and the small mass of our Recharge event. Recharge 2 is then triggered after the new hybridized Magma composition has cooled yet another 50 degrees. The higher mass and temperature of Recharge 2 is going to be enough to trigger the AFC, and as you can see by scrolling, we’re going to have assimilation occurring for the remainder of the run.

**16:54**