Mount Baker is an andesitic stratovolcano in the northern Cascade volcanic arc. The most primitive (basalt/high-Mg andesite) and most differentiated (dacitic) magma types have been analyzed to elucidate magma sources, but no studies have thus far been aimed at understanding the origin of the most voluminous component of this volcano, the andesites. I propose to examine the geochemistry of intermediate magmas of Mount Baker in the attempt to determine if the andesites are derived from the three parental magma types at Mount Baker identified by Moore and DeBari (2012): typical calc-alkaline basalt, high-Mg andesite and MORB-like low K tholeiite (LKT). I will also assess the role magma mixing and fractionation have in generating andesitic magmas. Furthermore, I propose to constrain the “parent-less” Nooksack Falls dacite with an andesitic magma source.

Hildreth et al. (2003) published the foundational study of Mount Baker’s eruptive chronology along with major element data for most flows. Despite this, the voluminous andesites erupted at Mount Baker have not been geochemically characterized and their origin remains unknown. It is important to study the intermediate magmas of Mount Baker considering andesitic volcanism is synonymous with arc volcanism and is the dominant magma type erupted in the Cascade volcanic arc (Carmichael, 2002). Commonly, intermediate magmas erupt as a result of felsic and mafic magmas mixing, and the diversity of lavas erupted at Mount Baker further suggests that recharge filtering (Kent et al., 2010) could exert an important control. However, other hypotheses for andesite generation can be simple fractionation from basalt with or without crustal contamination (Grove and Kinzler, 1986) or primary melting of subducted plates (Yogodzinski and Kelemen, 1998). In their study of Mount Baker lavas, Baggerman and DeBari (2011) state that intermediate magmas are not derived from a single source, and open-system processes are dominant during petrogenesis. However, compositions were limited to basaltic andesites and very felsic andesites to dacites, not intermediate compositions. Further setting the stage, Moore and DeBari (2012) showed that three mafic magma types come from distinct mantle sources beneath Mount Baker. One of the magma types, high-Mg andesites, have been shown to produce some dacitic compositions by fractional crystallization, and these dacites clearly undergo recharge mixing with more primitive compositions to provide complex differentiation histories (Gross, 2012; Baggerman and DeBari, 2011). However, this fractionation history and recharge mixing has only been quantitatively constrained for basaltic andesites and dacites. A missing link in these studies is the voluminous intermediate compositional range magmas, which may serve as parental magmas for dacites. These results will tie into the larger more global question about andesite genesis in arcs. Do andesites represent an intermediate liquid step along a fractionation sequence from basalt to dacite, or as suggested by Reubi and Blundy (2009), do they represent mixtures of crystals and liquid from distinct sources? And in either case, can they further fractionate to produce more felsic compositions.

This study will focus on the petrography and whole rock and mineral chemistry of the intermediate range magmas to determine their role as derivatives of basalts and parents of dacites by fractional crystallization or the result of mixing between mafic and felsic magmas. I have chosen four flows mapped by Hildreth (2003) ranging in 54 - 62 silica weight %, in an effort to collect a representative range of intermediate samples: Dobbs Creek, Dobbs Cleaver, Swift Creek and Coleman Pinnacle. In addition, Coleman Pinnacle is the only hornblende-bearing andesite at Mount Baker. I will discern if this hydrous magma series comes from a distinct mantle source, and if Coleman Pinnacle andesite is parental to the hornblende-bearing Nooksack Falls dacite (using fractional modeling). At least 30 samples from these four flows will be collected in summer 2013.

I will make detailed petrographic analyses of thin sections from these flows to determine the mineralogy and diversity of phenocrysts populations and to preselect phenocrysts for further analysis by microprobe and LA-ICPMS. Observations of disequilibrium textures and complex
zoning of phenocrysts will hint as to whether recharge mixing is occurring (Kent, 2010). Mineral chemistry by microprobe (major element) and LA-ICPMS (trace element) will be used to establish crystallization conditions and compositions for fractionation modeling. Microprobe analyses will be done at UW and LA-ICPMS analyses at WWU during the fall of 2013.

Whole rock major and trace element data will provide the geochemistry of the intermediate magmas, allowing for modeling calculations to determine relationship with the other mafic (Moore and DeBari, 2012) and felsic (Gross, 2012) magmas. These analyses will be done by ICPMS and XRF at WSU during the fall of 2013 due to the lack of facilities at WWU. Samples for whole rock analyses will be prepared at WWU in the summer of 2013. The end results will then be compared to the data of Gross (2012) and Moore and DeBari (2012) to evaluate the relationship of the andesites to the dacitic and mafic magmas of Mount Baker. As proposed in the hypothesis, characterizing andesite petrogenesis at Mount Baker, involving modeling techniques utilizing mineral and whole rock compositions, will provide a detailed big picture understanding of the diverse magmatic relationships identified at Mount Baker.

References