JÖKULHLAUPS IN ICELAND: CHARACTERISTICS AND IMPACT. H. Björnsson, Science Institute, Department of Geophysics, University of Iceland, Hofsvallagötu 53, IS-107 Reykjavík, Iceland. E-mail: hb@raunvis.hi.is

Introduction: Glacier outburst floods, jökulhlaups, are frequent in Iceland. They can be traced to three types of sources: to subglacial lakes at geothermal areas, to meltwater drained during volcanic eruptions and to marginal ice dammed lakes. Jökulhlaups are major events; they may profoundly affect landscape and they threaten human life and property. In Iceland, jökulhlaups have caused loss of lives, ruined farms and cultivated land, and devastated large vegetated areas. They threaten roads, bridges and hydroelectric power plants on glacier-fed rivers. Their effects on landscape are seen in the erosion of large canyons and in the transport and deposition of sediments over sandur deltas. The present lecture gives an overview of jökulhlaups in Iceland, their sources, triggering and drainage [1].

Volcanically Triggered Floods: Since the time of the settlement of Iceland (870 A.D.), at least 80 subglacial volcanic eruptions have been reported, many of them causing tremendous jökulhlaups. The peak discharge of the largest floods (from Katla beneath the Mýrdalsjökull ice cap) has been estimated at the order of 100-300,000 $m^3 s^{-1}$, duration was 3 -5 days and the total volume of the order of 1-8 km^3. Some of the floods may have consisted of a hyperconcentrated fluid-sediment mixture. The potentially largest and most catastrophic jökulhlaups may be caused by eruptions in the voluminous ice-filled calderas in northern Vatnajökull (of Bárdarbunga and Kverkfjöll). They may be the source of prehistoric jökulhlaups, with estimated peak discharge of 400,000 $m^3 s^{-1}$.

Subglacial Lakes: A few of the volcanoes contain geothermal systems maintaining permanent depressions, underlain by subglacial lakes that drain periodically in outburst floods. The best known depressions at geothermal areas are the Grímsvötn depression and the Skaftá cauldrons. Ice drains toward the Grímsvötn depression from an area of 160 km^2 where a geothermal system continuously melts ice at the rate of 0.2-0.5 $km^3 a^{-1}$ during normal times. The meltwater is trapped in a lake at the bed and normally the 250 m thick ice cover that floats on the lake rises 10-15 m per year. The seal is broken when the lake level has risen typically 80-150 m and the water flows 50 km beneath the glacier down to the Skeidarársandur outwash plain. Outburst floods from Grímsvötn have occurred at 1 to 10 year intervals, with a peak discharge of 600 to 40,000 $m^3 s^{-1}$ at the glacier margin, a duration of 2 days to 4 weeks and a total volume of 0.5 to 4.0 km^3. Typically the discharge increases approximately exponentially but having reached the peak, the discharge falls more rapidly. General models of discharge of jökulhlaups give in many respects satisfactory simulations for jökulhlaups from Grímsvötn. The best fit is obtained for the Manning roughness coefficients n = 0.08-0.09 $m^{-1/3}$ s. An empirical power law relationship is obtained between peak discharge and total volume of the jökulhlaups from Grímsvötn; $Q_{max} = K V_t^b$, where Q_{max} is measured in $m^3 s^{-1}$, V_t in $10^6 m^3$, K = 4.15 $10^{-3} s^{-1} m^{-2.52}$ and b = 1.84.

The two Skaftá cauldrons are situated at geothermal systems, 10-15 km to the northwest of Grímsvötn. Since 1955, at least thirty jökulhlaups have drained from the cauldrons to the river Skaftá. The ice cauldrons are approximately circular. The centre of the eastern cauldron subsides by about 100-150 m in a jökulhlaup draining a volume of 0.2-0.4 km^3 of water; the other cauldron by 50-100 m and drains a volume of 0.05-0.16 km^3. The period between these drainage events is about 2 to 3 years for each cauldron. The ice drainage area of the western and the eastern cauldrons have been estimated at 33 km^2 and 58 km^2, respectively. Typically the discharge risers rapidly and recedes slowly; form is in that respect a mirror image of the typical Grímsvötn hydrograph. The reservoir water temperature may be well above the melting point (10-20 °C) and the flowing water seems not to be confined to a tunnel but spread out beneath the glacier and later gradually collected back to conduits.

Marginal Lakes: At present, jökulhlaups originate from some fifteen marginal ice-dammed lakes in Iceland. Typical values for peak discharges are 1,000-3,000 m^3/s, duration 2-5 days and total volumes of 2,000 x 10^6 m^3. Hydro-graphs for jökulhlaups from marginal lakes have a shape similar to those of the typical Grímsvötn jökulhlaup.

References: [1] Björnsson, H. *Ann. Glaciol.* 16, 95-106.