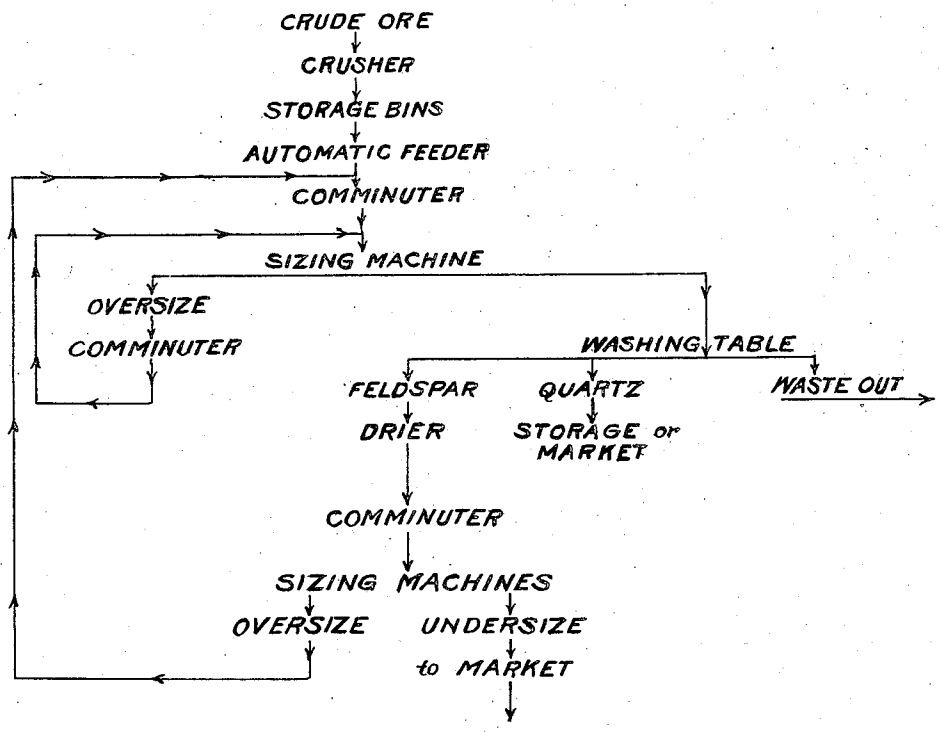
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METHOD OF SEPARATING FELDSPAR AND QUARTZ.

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METHOD OF SEPARATING FELDSPAR AND QUARTZ.

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To all whom it may concern:

Be it known that we, FRANK P. KNIGHT, a citizen of the United States, residing at Manchester, county of Essex, and State of Massachusetts, and JOHN T. SHIMMIN, a citizen of the United States, residing at Hurley, county of Grant, and State of New Mexico, have invented certain new and useful Improvements in Methods of Separating Feldspar and Quartz; and we do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

The invention relates to the novel process of separating feldspar and quartz as these elements occur in various natural matrices and ores, and simultaneously eliminating other mineral constituents and impurities so that the feldspar and quartz are recovered separately and in any desired degree of purity, as will be more particularly pointed out in the annexed specification, which is predicated by way of an example upon the separating plant illustrated schematically in the accompanying drawing.

The usual occurrence of feldspar in nature is in the form of deposits or dikes in which the feldspar is associated with quartz and various other minerals and impurities, as a conglomerate, and the methods heretofore employed for separating the commercially valuable products from the natural aggregate, containing feldspar and quartz, have been by means of hand selection or cobbing, or sorting the broken mass for the recovery of as much of the valuable minerals as is practicable by such methods. It is obvious that these methods confine the selection to the coarser-sized pieces only, and that, therefore, very large percentages of equally valuable minerals, in small sizes, will be left in the reject or waste because of the impracticability of picking them out. Large proportions of the larger crystals are also lost by reason of the necessity of breaking up the larger masses into small sizes for practicable hand selection, and all portions of the minerals smaller than the range of sizes practicable for hand selection go into the reject and are lost to the industry, and are accumulating in dumps at the mines. The primary object of the invention is to handle, by continuous method, the crystalline aggregate of the ores and matrices containing feldspar and quartz, as a whole, whether the ores be taken directly from the mine or recovered from the dumps, the method being effected in such manner that the feldspar and quartz will be recovered as refined separate products in a single operation, thereby greatly increasing the recovery of these valuable minerals and greatly reducing the costs of mining and separating them as heretofore practiced.

The specific gravities of feldspar and quartz are substantially the same and do not vary in sufficient degree to permit of their separation, either in whole or in part, by the usual processes of mechanical concentration, and all attempts at such separation have, therefore, resulted in failure. In consequence of these circumstances, it has been generally accepted as a fact that feldspar and quartz are incapable of mechanical separation by any of the well known devices employed for separating other mineral products, which differ among themselves in specific gravity to a sufficient degree to enable them to respond to the various separating and concentrating methods in vogue. Therefore, the recovery or separation of feldspar and quartz from ores containing these minerals has been limited exclusively to the wasteful method of hand selection, which does not admit of the recovery of more than from 20 to 40 percent of the desired minerals, and even the products thus recovered are frequently unfit for commercial use without further treatment, because of impurities of the admixtures of the desired minerals being present in practically inseparable proportions in the hand-selected elements of the ore or matrix.

The present invention is based upon two primary conditions, the first being the possibility of so far comminuting the ore, or mineral conglomerate carrying the feldspar and quartz that the several mineral constituents will be physically separated from each other as small individual particles, that is to say, in the case of admixtures of feldspar and quartz, such comminution will result in an admixture of substantially pure granules of feldspar on the one hand and substantially pure granules of quartz on the other; the second being predicated on the inflexible

natural laws that the two minerals, feldspar and quartz, have very marked differences in fracture and cleavage, the granules produced in crushing or comminuting them retaining their respective and peculiar properties of cleavage and fracture even to the remotest practical sub-division or comminution. Feldspar, that is, orthoclase, microcline, and albite, is distinguished by monoclinic and triclinic crystallization with prismatic angles closely approximating 60 and 120 degrees. These several forms of the mineral feldspar cleave in two directions in parallel planes, parting more easily in one set of planes than in the other, thereby affording flat surfaces parallel with each other in grains that are broader and longer than they are high, and with sharp angles and wedge-shaped sections on one-half of their edges.

The mineral quartz, or silica, is distinguished by its concoidal fracture and entire lack of regular lines of cleavage, so that when the mineral is broken up into granules, or reduced to a state of comminution, the individual particles have substantially the same dimensions as to length, breadth and thickness, that is to say, quartz grains, of whatever size, average as high as they are long or wide. These individual characteristics, as to general shape and fracture of the granules or particles of feldspar and quartz, cause the particles or granules of the same size, of the respective minerals, to move at different rates over a relatively smooth surface under the influence of an impelling force, due to the difference in the resistance or opposition to movement, that is to say, the uniformly sized particles of quartz, generally concoidal in form, will move faster over the surface than would granules of the same size of feldspar, which latter interposes flat surfaces and sharp angles to the supporting surface and would, therefore, oppose a larger element of resistance to movement under the same impelling force than would the quartz granules, with the result that the granules of quartz will collect in strata or bands on one section of the surface, while the slower moving granules of feldspar will collect in a different area or band.

We have found that by crushing and comminuting the ores and matrices containing feldspar and quartz, as a whole, down to the proper size grains to cleave the feldspar and quartz from each other, and incidentally to divide the other mineral matters and impurities from the quartz and feldspar, and from each other, it is possible to divide ponderable portions of the resulting mass into classes or grades of substantially the same size grains, the various grains being intermixed, but individually consisting of practically pure quartz, pure feldspar, etc. After the mass has thus been sized, classified or graded, the individual grades are separately treated on an inclined plane surface under a sheet of moving water, the inclination of the surface and the rate of flow of the water being so regulated that the granules of the individual minerals, feldspar and quartz, will be sorted and assembled in bands on the surface, by reason of the differences in the shape of the granules, as hereinbefore explained, and these water-classified bands may be removed as marketable products of materially increased uniformity and purity than has been possible of realization with any method of separation heretofore known. It has been found in practice that with a mass of grains of substantially the same size and specific gravity being transported on a slightly inclined surface by a gently moving current of water, the lag of the grains on the surface will vary in accordance with the resistance offered by the grains by reason of their shapes. The quartz grains, being as high as they are wide or long, will be rolled over readily, by the moving current, and will be assorted in a band by themselves. The feldspar grains, having flat surfaces, conforming closely to the plane on which they lie, and having wedge-shaped ends also to oppose the current, and being of less height than length and breadth, will oppose a materially greater resistance of movement by the flowing water than the quartz grains and will consequently lag behind the latter and be assorted into a separate class or band. Similarly the other mineral constituents, as well as the impurities in the comminuted ore mixture, all of which are in substantially uniformly sized classes, will congregate in different areas and be separated from both the band of feldspar and the bands of quartz. If a differential movement, generally similar to that typical of concentrating machines, be imparted to the inclined surface or table, and so regulated as to move the resultant bands forward and beyond the influence of the sorting liquid stream, these two factors or forces may be caused to work in conjunction, so that the mineral constituents indicated will first be sorted into separate bands and said bands advanced over the surface of the table to ultimate points of discharge, where they may be collected in different receptacles, each receptacle receiving its own particular mineral element, in the case under consideration the desired elements being feldspar and quartz, although obviously the other mineral constituents may also be separately collected while the undesired elements and impurities may be discharged as tailings or waste.

We have found that several of the types of table concentrators, well known in the

art of concentration, as predicated upon difference of specific gravity of the constituents of an ore, are well adapted to make the separation contemplated by the present method, by reason of the different forms of the mineral granules, but without respect to the difference in specific gravity of the granules. We have also found that concentrating machines of the flattened cone type, known as "Buddles," for the same reason may be adapted to make the separation contemplated by the present invention. The inclination of the table and the rate of flow of the water thereover to effect the desired result may be readily determined and when once ascertained will be effective under all normal conditions of operation, and, as indicated, the differential movement usually imparted to concentrator tables will be effective in advancing the separated bands of the different minerals forward over the table and out of the influence of the separating liquid stream or sheet, so that the different mineral elements may be separately collected.

Obviously it is not possible to grind or crush minerals of this general character to reduce all the elements thereof to grains of the same uniform size, and it is for this reason that the comminuted ore aggregate is graded according to the size of the granules, and the several grades or sizings separately treated on the separating tables for the reason that the successive separation of the different mineral constituents into bands is dependent upon the condition precedent that the grains, granules, or particles undergoing separation be of the same or substantially the same size. Obviously, therefore, several sizing tables may be provided to receive different sizes or grades of the comminuted ore, so that the entire volume of a given batch of ore may be treated in one continuous operation and the feldspar and quartz constituents thereof separately collected from each table.

In the accompanying drawing a schematic diagram of a plant for putting the method aforesaid into practical operation is illustrated. In the diagram the crude ore is represented as being passed through a crusher, which breaks up the larger elements of the ore to adapt the same to be uniformly fed to a suitable comminuting machine. Preferably the crushed ore is delivered to storage bins, from which it may be taken by automatic feeding means, which deliver the crushed ore to the comminuter, which latter may be any of the well known wet type machines, or mills capable of reducing the ore to a state of comminution which will insure the cracking or separation of the quartz and feldspar from the matrices as separate grains or granules of quartz and felds ar respectively, and similarly crack off or separate the other mineral constituents as separate grains. The comminuter may be in the form of a rod mill, roller mill, or ball mill, or in fact any other type of mill calculated to economically produce the desired result. From the comminuter the granulated ore is passed to a sizing machine, which may be of any suitable or well known type, such, for example, as a series of superposed sieves or screens. The several sizes or grades of the comminuted ore delivered from the sizing machine are separately fed to washing tables, of the character described, each of the sized batches preferably being delivered to a separate table, while the over-sized granules or particles are diverted to a second comminuter and thence back to the sizing machine whence they are distributed to their proper washing tables. Each of the washing tables operates to separate the comminuted ore into bands or sections, each containing only one element of the ore, such as feldspar and quartz, which are delivered by the differential movement of the table from different sections of the latter, the quartz being deposited at one section of the table ready for the market or storage for future use, while the feldspar is delivered from another section of the table. The other mineral elements, which it may be desired to save, are similarly separated and collected by the operation of the table, while the waste is delivered separately from the table as tailings.

Inasmuch as commercial feldspar, in its best marketable form, must be in a state of very fine sub-division and thoroughly dry, the feldspar product delivered from the washing table or tables is passed through a suitable drying apparatus, which will not only drive off the moisture, but will feed the product through it under conditions of continuous agitation to prevent agglomeration of the feldspar particles. From the dryer the thoroughly dried feldspar is passed through a comminuting machine which reduces most of it to marketable sizes, which are taken out by a sizing machine of appropriate character, and which may be similar to the first mentioned sizing machine, the over-sized particles being separately discharged from the sizing machine and delivered to the first comminuter for re-treatment in the entire cycle of operations following the original comminution of the ore, that is to say, the over-sized feldspar particles are admixed with the ore entering the first comminuter and passed through all the subsequential operations. In the alternative, the over-sized feldspar particles may be passed to the first sizing machine following the original comminuter with a fair chance that the majority of such particles will be diverted by the first sizing machine to the second comminuter, whence they are

passed back in regular order to the sizing machine, and, if of the proper size, are then delivered to the proper washing table.

The degree of comminution to which the original ore is subjected will be dependent in a large measure upon the relative purity of the desired feldspar and quartz, obviously if a practically pure product is required, the ore must be reduced to such fine granular condition that each grain will consist only of a single mineral element, such as feldspar, quartz, and any of the other minerals found in ores of this general character. If a less pure product is satisfactory, a lesser sub-division of the original ore will suffice, provided none of the granules contain coherent mixtures of the other mineral elements with the feldspar in excess of the amount permitted in the particular use to which the feldspar is to be put.

What we claim is:

1. The method of separating quartz and feldspar occurring in mineral aggregate, which comprises comminuting the aggregate to a degree sufficient to effect liberation and separation of the granules of the respective minerals each from the other, washing the comminuted mass on an inclined surface, and controlling the flow of the washing medium over the surface aforesaid to cause the respective minerals to separate into bands in accordance with their respective resistances to movement imparted thereto by the washing current.

2. The method of separating quartz and feldspar occurring in mineral aggregate, which comprises comminuting the aggregate to a degree sufficient to effect liberation and separation of the granules of the respective minerals each from the other, washing the comminuted mass on an inclined surface, controlling the flow of the washing medium over the surface aforesaid to cause the respective minerals to separate into bands in accordance with their respective resistances to movement imparted thereto by the washing current, and imparting a differential movement to the inclined surface to move the respective band forward out of the influence of the washing current and discharge the assorted bands separately.

3. The method of separating quartz and feldspar occurring in mineral aggregate, which comprises comminuting the aggregate to a degree sufficient to effect liberation and separation of the granules of the respective minerals each from the other, assorting the granular pulp thus produced into classes having substantially the same sized grains, but of different shapes due to the laws governing their cleavage, washing each of the classes of comminuted grains on an inclined surface, and controlling the flow of the washing medium over the surface aforesaid to cause the respective minerals to separate into bands in accordance with the shapes of the particles of said minerals.

In testimony whereof we affix our signatures.

FRANK P. KNIGHT.
JOHN T. SHIMMIN.