

SUCTION HEAD FOR A DREDGING VESSEL AND METHOD FOR DREDGING USING THIS SUCTION HEAD

The invention relates to a suction head for a dredging vessel. The invention likewise
5 relates to a dredging device comprising a dredging vessel configured for movement in a
direction of movement, a dredge pump placed on the dredging vessel and having a
suction connection, a suction conduit connecting the suction head to the suction
connection of the dredge pump, and support means placed between the dredging vessel
and the suction head for supporting the suction conduit, the support means being
10 configured to determine the depth of the suction head. The invention further relates to a
method for dredging bottom material using this suction head, and particularly bottom
material comprising clay.

A known dredging device and suction head are for instance described in EP-A-0892116.
15 The known suction head comprises a construction provided on the bottom side with a
suction opening and having a connection for a suction conduit of the dredging vessel.
Arranged at the rear (the downstream side relative to the direction of movement) of the
construction is a visor which is open on the bottom side and connected for pivoting
around a horizontal shaft to the construction, and can thus be rotated up and downward,
20 for instance by a hydraulic piston. The visor is further provided with a toothed beam
running transversely of the direction of movement and provided on the bottom side with
teeth for dislodging material for dredging from the bottom. A series of wear heel pieces
together forming the heel plate are arranged if desired on the underside (the bottom
side) of the construction, at the position of the connection to the visor. During use such
25 a suction head is dragged forward over or in the bottom for dredging, wherein the
suction head rests with the heel plate on the bottom and wherein the teeth dislodge the
bottom and the loosened bottom material is suctioned away via the suction conduit, for
instance to a bin present on the dredging vessel.

30 Because the construction rests with the heel plate on the bottom, the visor can rotate
independently of the construction. If the visor is controlled at a constant force using the
hydraulic piston, the visor will then follow the bottom contour, wherein the rear wall
and the side walls of the visor penetrate the bottom to a lesser or greater extent
depending on the bottom hardness. Owing to the suction action of the suction conduit an

underpressure will be built up in the suction head which depends on, among other factors, the extent of sealing of the suction head. The built up underpressure provides for suction of dredged bottom material.

- 5 Although the known suction head has a good efficiency when dredging determined soil types, the efficiency can be significantly lower particularly when bottoms comprising clay are being dredged.

10 The present invention has for its object to provide a suction head for a dredging vessel with which bottoms, particularly bottoms comprising clay, can be dredged with an improved efficiency compared to the known suction head. Within the context of this application efficiency is understood to mean the volume of bottom material which can be dredged per unit of time and per unit of power.

- 15 Provided according to the invention is a suction head for a dredging vessel configured for movement in a direction of movement, wherein the suction head comprises a construction provided on the bottom side with a suction opening and having a connection for a suction conduit of the dredging vessel and a visor rotatable around a shaft running transversely of the direction of movement between a lowered and a raised position, wherein a curved wall part of the visor is slid in substantially watertight manner along a wall part of the suction head, wherein the visor comprises on the bottom side thereof a toothed beam running transversely of the direction of movement P and provided with a series of cutting tools for penetrating the bottom, and wherein the visor comprises an opening in its rear wall along which surrounding water can flow into the suction head and which opening can be closed to the surrounding water by means of a closing member. The invented suction head has been found able to dredge bottoms with an improved efficiency compared to the known suction head. Good results are achieved particularly in the case of bottoms comprising clay. Providing the visor of the suction head at the rear (downstream) thereof with a closable opening enables surrounding water to flow in when the closing member is opened. It has been found that, particularly in the case of bottoms comprising clay, a quantity of clay accumulates in the interior of the suction head during dredging, whereby the suction head and the visor may become at least partially blocked. The clay accumulation is reduced or even avoided by
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regularly leaving the opening clear using the closing member. Dredging with a high efficiency hereby remains possible.

5 It is important to select a sufficiently large total surface area of the opening to achieve the desired flushing effect. Provided for this purpose according to an embodiment of the invention is a suction head wherein the opening covers at least 30% of the surface area of the visor wall part extending from the toothed beam up to the curved wall part of the visor. This is more preferably at least 50%, still more preferably at least 75%.

10 Another embodiment of the suction head according to the invention has an opening extending substantially from the toothed beam up to the curved wall part of the visor. In this embodiment a maximum inflow height for inflowing surrounding water is achieved without the possibility of problems occurring with the substantially watertight seal between the curved wall part of the visor and the corresponding wall part of the suction
15 head when the visor is in a raised position.

Provided in yet another embodiment according to the invention is a suction head wherein the opening extends transversely of the direction of movement over at least 30% of the width of the suction head, more preferably at least 50%, still more
20 preferably at least 70%, and most preferably at least 80%.

In an embodiment the suction head according to the invention is characterized in that the closing member comprises a slide which can slide relative to the visor wall part between a position in which the opening is substantially closed and a position in which
25 the opening is left wholly or partially clear. In a suitable embodiment the slide is slidable in substantially watertight manner and parallel to the visor wall part. The visor wall part can here be curved or, conversely, substantially flat. It will be apparent that the slide will have a corresponding form. In this embodiment the opening can be left clear in simple manner by sliding the slide relative to the opening, wherein a control of the
30 inflow area is possible by controlling the height position of the slide. During sliding of the slide along the edges of the opening, bottom material adhered to the inner surface of the slide will moreover be skimmed therefrom, this facilitating flushing away along the opening of the bottom material accumulated in the interior of the suction head.

Yet another embodiment according to the invention relates to a suction head wherein the closing member comprises a part of the visor wall part, which part is connected for pivoting around a shaft running transversely of the direction of movement P to another part of the visor wall part.

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Particularly advantageous is a suction head wherein the closing member comprises a wall part which is connected for rotation around a rotating shaft running transversely of the direction of movement P to a support structure connected to the visor. Such an embodiment requires little maintenance to the mechanism of the closing member, making it reliable. A variant of this embodiment of the suction head is characterized in that the support structure places the rotating shaft of the wall part of the closing member at a distance from the rear wall of the visor, wherein the support structure comprises supporting walls preferably running at a right angle to the rear wall of the visor and connected by means of a cross beam running transversely of the direction of movement P. A particularly suitable method of mounting the wall part on the support structure is provided by an embodiment wherein the support structure comprises yokes which extend between the cross beam and the toothed beam of the visor and to which carriers for the wall part of the closing member are rotatably connected.

Rotating the carriers relative to the yokes around an axis or axes running transversely of the direction of movement of the suction head will move the wall part of the closing member supported by the carriers along the opening in the rear wall of the visor, whereby the opening is left partially or wholly clear. In the present embodiment the opening can easily be left completely clear without the possibility of parts of the closing member becoming jammed. In the closed position of the closing member the wall part thereof preferably connects substantially watertightly to a wall part of the support structure and/or the visor rear wall. In order to avoid the possibility of the closing member rotating too far upward the closing member and/or the support structure is preferably provided with an end stop to prevent this excessive rotation. It is also possible to limit the rotation of the closing member in the other direction by means of an end stop.

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Although it is possible to operate the closing member manually and for instance secure it in a fixed position, an embodiment of the suction head comprises control means for

the closing member. The invention is in principle not limited to a determined type of control means. Particularly suitable control means comprise hydraulic pistons which are remotely controllable, for instance from the bridge of the dredging vessel. The hydraulic pistons for instance connect a part of the closing member and/or support structure to a fixed part of the suction head. Activation of the hydraulic pistons provides for an extending or retracting of the piston plunger, whereby the relevant part of the closing member and/or the support structure is displaced relative to the fixed part of the suction head. Hydraulic pistons are able to provide the forces required to operate the closing member.

The movable wall part of the closing member can extend transversely of the direction of movement of the suction head over a part of the width thereof, but will preferably extend over substantially the whole width thereof. It can be advantageous here that the wall part of the closing member comprises transversely of the direction of movement of the suction head a number of substantially connectable sections movable independently of each other. Each section can in this way be moved independently of another section, wherein the inflow area of the cleared opening can be varied over the width of the suction head. This can further increase the efficiency in that inflow of surrounding water takes place only over a part of the opening where it is necessary.

The suction head according to the invention can be provided with cutting tools in any conceivable form. The cutting tools can thus comprise teeth, although it is also possible to provide the suction head with cutting tools which are rotation-symmetrical, preferably conical, at least at their free outer end. Such cutting tools have the advantage, among others, that they can withstand higher loads than the known teeth. The cutting tools will usually form at least one series extending along a straight line, substantially transversely of the direction of movement of the suction head, although this is not essential for the invention. The mutual distance between the cutting tools is determined by, among other factors, the dimensions of the cutting tools themselves and by the overall weight of the suction head and suction conduit parts located under water, divided by the number of cutting tools. The towing force developed by the dredging vessel can also be important. In addition, the properties of the bottom for dredging are important, for instance the pressure strength/tensile strength ratio of the bottom.

Provided in another aspect of the invention is a suction head provided with nozzles directed toward the internal space of the suction head for the purpose of ejecting liquid, preferably water, under pressure. In a preferred embodiment the closing member comprises nozzles directed toward the internal space of the suction head for the purpose of ejecting a liquid, preferably water, under pressure. In another embodiment the heel plate of the suction head comprises nozzles directed toward the internal space of the suction head for ejecting a liquid, preferably water, under pressure.

In a suitable embodiment of the suction head the nozzles form a series extending along a line transversely of the direction of movement P of the suction head, preferably over substantially the whole width of the suction head. The nozzles preferably operate under a pressure of a maximum of 50 bar, more preferably a maximum of 30 bar, and most preferably a maximum of 15 bar. The liquid jets generated by the nozzles under such pressures are configured to cut up and spray away bottom material accumulated in the suction head, and particularly in the visor. The efficiency of the suction head is hereby further improved and a good suctioning of dislodged bottom material is hereby achieved. The nozzles thus assist in discharging dredged bottom material via the suction conduit. In an embodiment in which the nozzles are present on the closing body, the water jets will cover a large part of the interior of the suction head when the closing body is moved.

Provided in yet another aspect of the invention is a suction head wherein the suction head is provided internally at the position of the connection for the suction conduit of the dredging vessel, more specifically at the position of the connection between the visor and the fixed part of the suction head, with a push-out grating for removing bottom material adhered to the curved wall part of the visor. During partial raising of the visor the curved wall part of the visor slides along a corresponding wall part of the suction head. Bottom material adhered to the curved wall part of the visor comes into contact here with the push-out grating, whereby this bottom material is skimmed at least partially off the curved wall part. In an improved embodiment the push-out grating runs substantially at a right angle to the curved wall part of the visor.

The invention also relates to a method for dredging bottoms, particularly bottoms comprising substantially clay, with a dredging vessel equipped with a suction head

according to the invention. The method comprises of carrying a suction head according to the invention to the bottom, after which it is dragged forward over the bottom. The suction head is lowered here onto the bottom and dragged in a direction of movement over the bottom for dredging, this such that the cutting tools make contact with the bottom. The closing member closes the opening at least partially, preferably wholly, here until an (excessively) large amount of bottom material has accumulated in the interior of the suction head. The opening in the rear wall of the visor is then at least partially opened by operating the closing member so that surrounding water is carried into the suction head and the bottom material accumulated in the suction head is skimmed off by the closing member and removed under the influence of the inflowing water and the suction action of the dredge pump. The accumulated bottom material can be discharged via the opening and/or via the suction opening. Once the greater part of the bottom material has been removed from the interior of the suction head, the opening is closed once again by moving the closing member.

The suction head according to the invention is particularly suitable for dredging bottom material substantially comprising clay.

The suction head and method according to the invention will now be further elucidated on the basis of the following description of preferred embodiments and figures, without the invention being limited thereto. In the figures:

- figure 1 is a schematic side view of a dredging device according to the invention;
- figure 2 is a schematic side view of an embodiment of a suction head according to the invention;
- figure 3 is a schematic perspective view of the visor of the suction head according to the invention shown in figure 2 in closed position;
- figure 4 is a schematic perspective view of the visor of the suction head according to the invention shown in figure 2 in open position;
- figure 5 is a schematic perspective top view of the visor shown in figure 4;
- figure 6 is a schematic perspective side view of the visor of the suction head according to the invention shown in figure 2 in open position;
- figure 7 is schematic perspective side view of the visor shown in figure 6 in closed position, and finally

figure 8 is a perspective bottom view of another embodiment of the visor according to the invention provided with nozzles.

- Figure 1 shows a dredging vessel 1 which is provided with a motor, not shown in the drawing, for driving a propeller 2 via a propeller shaft for the purpose of propelling dredging vessel 1. Also present are devices, not shown in the drawings, for steering dredging vessel 1, such as a rudder and transversely placed propellers for facilitating manoeuvring.
- 10 A dredge pump, not shown in the drawings, is arranged in dredging vessel 1. Arranged against a side wall of the dredging vessel is a suction conduit 3, one end of which is connected to the suction connection of the dredge pump. In the present embodiment the suction conduit 3 comprises two members 3a and 3b which are connected to each other by means of a coupling allowing some relative angular displacement. The connection
15 between upper member 3a of suction conduit 3 and the vessel also allows angular displacement in the vertical plane and about the axis. For support of the movable end of upper member 3a of suction conduit 3 this member is connected to a cable 4a, the other end of which is connected to a winch 5a. For support of the movable end of lower member 3b of suction conduit 3 this member is likewise connected to a cable 4b, the
20 other end of which is connected to a winch 5b. It is thus possible using winches 5a, 5b to vary the height of suction conduit 3. It will be apparent that, also subject to the depth of the basin for dredging, the number of members of suction conduit 3 can be increased or decreased, with a corresponding adjustment of the number of cables 4 and winches 5.
- 25 A suction head 6 according to the invention is arranged on the free end of second member 3b of suction conduit 3. Referring to figure 2, an embodiment of suction head 6 is shown. Suction head 6 comprises a construction 7 connectable to suction conduit 3 and having side walls 7a, 7b (only 7a is visible), an upper wall 7c and a lower wall 7d facing toward the bottom. Arranged at the rear (the downstream side relative to the
30 direction of movement P) of construction 7 is a visor 81 with side walls 8 which is open only on the bottom side and which is connected to construction 7 for pivoting around a horizontal axis 9 and can thus be rotated up and downward by a hydraulic piston 12. Visor 81 with side walls 8 is further provided with a toothed beam 10 running transversely of the direction of movement P and provided on the bottom side with teeth

11 for dislodging material for dredging from the bottom. Arranged on the underside of construction 7 is a series of wear heel pieces which together form a heel plate 13. In order to prevent lateral inflow of surrounding water, suction head 6 can also be provided with a number of lateral, knife-like wear strips 14. During dredging the known suction
5 head 6 supports with heel plate 12 on the bottom, wherein visor 81 can rotate independently of construction 7. The desired penetration depth of teeth 11 into the bottom is controlled with the rotation of visor 81. The rotation takes place between a lowered position and a raised position, wherein a curved wall part 8a of visor 81 slides in substantially watertight manner (by means of seal 7f) along wall part 7c of the
10 suction head. In the raised position the curved wall part 8a of visor 81 will have slid substantially wholly along wall part 7c of the suction head. In the lowered position the curved wall part 8a of visor 81 will have slid substantially wholly out of wall part 7c of the suction head. This position is shown in figure 2. Teeth 11 dislodge the bottom, and the loosened bottom material is suctioned away via suction conduit 3, for instance to a
15 bin present on dredging vessel 1.

According to the invention rear wall 8b of visor 81 comprises an opening 15 along which surrounding water can flow from outside into suction head 6. Opening 15 can be closed to the surrounding water by means of a closing member 20. In the shown
20 embodiment closing member 20 comprises a wall part 21 connected for rotation around a rotating shaft or shafts 22 running transversely of the direction of movement P to a support structure connected to visor 81. The support structure comprises support walls (23a, 23b) which run at a right angle to rear wall 8b of visor 81 and are on the one hand mutually connected by means of a cross beam 24 running transversely of the direction
25 of movement P and on the other to the toothed beam 10 likewise running transversely of the direction of movement P. The support structure further comprises yokes (25a, 25b) which extend between cross beam 24 and toothed beam 10 of visor 81 and to which carriers (26a, 26b) for wall part 21 of closing member 20 are connected for rotation around shafts 22. The support structure thus places rotating shaft 22 of wall part 21 of
30 closing member 20 at a distance 27 from the rear wall 8b of visor 81. The support structure is connected by means of eye 28 to hydraulic cylinder 12. Because the support structure is connected fixedly to (the rear wall 8a of) visor 81, hydraulic cylinder 12 retains its function of moving visor 81 up and downward.

In a preferred embodiment suction head 6 is further provided internally, at the position of the connection for suction conduit 3b of dredging vessel 1, and more specifically at the position of the connection between visor 81 and the fixed part of suction head 6, with a push-out grating 37 for removing bottom material adhered to the curved wall part 8a of visor 81. Push-out grating 37 runs substantially at a right angle to the curved wall part 8a of visor 81 and bottom material which may be adhered to the curved wall part 8a of visor 81 will be skimmed therefrom when visor 8 is rotated around shaft 9 from a lowered position to a more raised position, wherein a curved wall part 8a moves along wall part 7c of suction head 6.

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As for instance shown in figures 4 and 5 in perspective view and in figures 6 and 7 in side view, wall part 21 is rotated about shafts 22 from a closed position shown in figure 7, in which wall part 21 closes the opening 15 substantially completely, to an open position shown in figures 4, 5 and 6 in which wall part 21 leaves opening 15

substantially completely clear and overlaps with a closed wall part 35. The rotation of the carriers (26a, 26b) can for instance be performed by means of hydraulic pistons (not shown), wherein the hydraulic pistons are preferably remotely controllable. Wall part 21 can form a whole as seen in the width, but can if desired also comprise a number of sections which are substantially connectable and if desired also movable independently of each other.

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In the embodiment shown in the figures closing member 20, and more specifically wall part 21, extends transversely of the direction of movement of suction head 1 over substantially the whole width of the suction head. Opening 15 also extends over substantially the whole width of the suction head. As will be further apparent from for instance figures 6 and 7, opening 15 extends substantially from toothed beam 10 up to the curved wall part 8a of visor 81.

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If wall part 21 is rotated from the closed position of figure 7 to the open position of figure 6, bottom material which has adhered to the inner surface of wall part 21 will be scraped off along the edge 45 of opening 15 and come to lie in the interior of visor 81, where it is discharged by water flowing in via opening 15. In the embodiment shown in figure 8 the suction head, and more specifically wall part 21 of closing member 20, is provided with nozzles 30 directed toward the internal space of suction head 1 for the

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purpose of ejecting a liquid, preferably water, under pressure. Nozzles 30 form a series extending along a line 31 transversely of the direction of movement P of suction head 1. Because figure 8 shows a bottom view of visor 81, side walls 8 are visible, as are a number of strengthening ribs 38 located between side walls 8 and running parallel thereto. The underside of the curved wall part 8a is also visible. Wall part 21 is in the open position in which opening 15 is left substantially completely clear. Nozzles 30 lie at the position of lower edge 21a (see also figures 6 and 7) of wall part 21 so that the series of nozzles 30 is still just visible in the shown open position. During closing of wall part 21 the series of nozzles 30 will be moved downward in the direction of toothed beam 10 so that a substantial part of the internal space of visor 81 is covered by the liquid jets.

Using the suction head 6 described in detail above underwater dredging of particularly a bottom comprising substantially clay is possible with increased efficiency, for which purpose the suction head is mounted on suction conduit 3 of a dredging vessel 1 and lowered to the bottom and dragged forward thereover in a dragging direction P, this such that cutting tools 11 make contact with the bottom. Because clay soil accumulates quickly in the internal space of visor 81, the opening 15 at the position of rear wall 8b of visor 81 is regularly opened at least partially by operating closing member 20 so that surrounding water is carried into suction head 1 and the bottom material accumulated in the suction head is skimmed off by closing member 20, in particular by wall part 21 thereof, and is removed by the inflowing water, optionally by nozzles 30 and push-out grating 37.

The invention is not limited to the above described exemplary embodiments, and modifications can be made thereto to the extent these fall within the scope of the appended claims.

Claims

1. Suction head (6) for a dredging vessel (1) configured for movement in a direction of movement P, wherein the suction head (6) comprises a construction (7)
5 provided on the bottom side with a suction opening and having a connection for a suction conduit (3) of the dredging vessel (1) and a visor (81) rotatable around a shaft (9) running transversely of the direction of movement P between a lowered and a raised position, wherein a curved wall part (8a) of the visor (81) is slid in substantially watertight manner along a wall part (7c) of the suction head (6), wherein the visor (81)
10 comprises on the bottom side thereof a toothed beam (10) running transversely of the direction of movement P and provided with a series of cutting tools (11) for penetrating the bottom, and wherein the visor (81) comprises an opening (15) in its rear wall (8b) along which surrounding water can flow into the suction head (6), and which opening (15) can be closed to the surrounding water by means of a closing member (20).
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2. Suction head as claimed in claim 1, wherein the opening covers at least 50% of the surface area of the visor wall part extending from the toothed beam up to the curved wall part of the visor.
- 20 3. Suction head as claimed in claim 1 or 2, wherein the opening extends substantially from the toothed beam up to the curved wall part of the visor.
4. Suction head as claimed in any of the foregoing claims, wherein the opening extends transversely of the direction of movement P over at least 80% of the width of
25 the suction head.
5. Suction head as claimed in any of the foregoing claims, wherein the closing member comprises a slide which can slide relative to the visor wall part between a position in which the opening is substantially closed and a position in which the
30 opening is left wholly or partially clear.
6. Suction head as claimed in any of the foregoing claims, wherein the closing member comprises a part of the visor wall part, which part is connected for pivoting

around a shaft running transversely of the direction of movement P to another part of the visor wall part.

7. Suction head as claimed in any of the foregoing claims, wherein the closing
5 member comprises a wall part which is connected for rotation around a rotating shaft running transversely of the direction of movement P to a support structure connected to the visor.

8. Suction head as claimed in claim 7, wherein the support structure places the
10 rotating shaft of the wall part of the closing member at a distance from the rear wall of the visor.

9. Suction head as claimed in claim 8, wherein the support structure comprises
supporting walls running at a right angle to the rear wall of the visor and connected by
15 means of a cross beam running transversely of the direction of movement P.

10. Suction head as claimed in claim 9, wherein the support structure comprises
yokes which extend between the cross beam and the toothed beam of the visor and to
which carriers for the wall part of the closing member are rotatably connected.
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11. Suction head as claimed in any of the foregoing claims, comprising control
means for the closing member.

12. Suction head as claimed in claim 11, wherein the control means comprise
25 hydraulic pistons which are remotely controllable.

13. Suction head as claimed in any of the foregoing claims, wherein the wall part of
the closing member comprises transversely of the direction of movement of the suction
head a number of substantially connectable sections movable independently of each
30 other.

14. Suction head as claimed in any of the foregoing claims, wherein the closing
member comprises nozzles directed toward the internal space of the suction head for the
purpose of ejecting a liquid under pressure.

15. Suction head as claimed in claim 14, wherein the nozzles form a series extending along a line transversely of the direction of movement P of the suction head.
- 5 16. Suction head as claimed in any of the foregoing claims, wherein the suction head is provided internally, at the position of the connection between the visor and the fixed part of the suction head, with a push-out grating for removing bottom material adhered to the curved wall part of the visor.
- 10 17. Suction head as claimed in claim 16, wherein the push-out grating runs substantially at a right angle to the curved wall part of the visor.
18. Dredging device comprising a dredging vessel configured for movement in a direction of movement P and a suction head as claimed in any of the claims 1-17
- 15 connected to the dredging vessel.
19. Method for dredging bottom material under water with a dredging vessel equipped with a suction head as claimed in any of the claims 1-17, wherein the suction head is dragged in a direction of movement over a bottom for dredging, this such that
- 20 the cutting tools make contact with the bottom, and wherein the opening in the rear wall of the visor is at least partially opened by operating the closing member so that surrounding water is carried into the suction head and bottom material possibly accumulated in the suction head is skimmed off by the closing member and removed.
- 25 20. Method as claimed in claim 19, wherein the bottom material substantially comprises clay.